2006 STORMWATER REPORT

September 2006

Washington State
Department of Transportation

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Cover Sheet

2006 Stormwater Report:

The eleventh annual report for National Pollutant Discharge System Elimination Multiple Separate Storm Sewer System Permits WASM 10001, WASM 20001, and WASM 30001 covering the Cedar-Green, Island-Snohomish, and South Puget Sound Water Quality Management Areas.

Submitted By:

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Abstract:

This report documents the progress made by WSDOT to protect water quality within the NPDES permit areas between July 1, 2005 and June 30, 2006. Progress is described using performance measures designed to gauge compliance with Stormwater Management Plan commitments, permit conditions and water quality standards. Major sections include a summary of stormwater priorities and spending, maintenance activities to protect water quality, construction site erosion control effectiveness, stormwater treatment facility effectiveness testing and research, and stormwater treatment facility construction.

The greatest achievements in this reporting period include 1) completing the construction of the 759th stormwater treatment facility since the permits were issued and 2) greatly expanding the data set documenting the effectiveness of WSDOT's stormwater treatment facilities.

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ACRONYMS

ADT – Average Daily Traffic

BMP - Best Management Practices

CFR - Code of Federal Regulations

ESA - Endangered Species Act

ESC Lead - Erosion and Sediment Control Lead

IVM - Integrated Vegetation Management

NPDES - National Pollutant Discharge Elimination System

RCW - Revised Code of Washington

QAPP - Quality Assurance Project Plan

TESC - Temporary Erosion and Sediment Control

TPH - Total Petroleum Hydrocarbons

TSS - Total Suspended Solids

WAC – Washington Administrative Code

WSDOT - Washington State Department or Transportation

Chapter 1 Overview

Why does WSDOT create annual Stormwater Reports?

Annual Stormwater Reports are prepared to inform the public and the Department of Ecology (Ecology) about progress made by the Washington State Department of Transportation (WSDOT) to protect water quality. Annual reports describe progress using performance measures designed to gauge compliance with Stormwater Management Plan commitments, permit conditions and water quality standards. The purpose of this annual report is to document stormwater-related activities within the permit areas between July 1, 2005 and June 30, 2006. This report is very similar to last year's report (WSDOT 2005) as most water quality protection programs are well established. Each section contains updated information including a large expansion of WSDOT's data set regarding stormwater treatment effectiveness.

Section 6 of this report contains the largest single data set regarding the effectiveness of stormwater treatment facilities in Washington.

Why does the WSDOT manage stormwater?

There are over 7,000 miles of highway, numerous rest areas, and park and ride lots in Washington. Collectively those facilities cover at least 35,000 acres with pavement that does not let water soak into the ground. Accordingly, billions of gallons of stormwater run off of state highways each year. The

For every inch of rain that falls from the sky onto an acre of pavement, about 25,000 gallons of stormwater is produced.

water, along with any pollutants that wash off of the highways, must be properly managed to prevent water quality and flooding problems.

How is stormwater management regulated?

The federal Clean Water Act requires that highway runoff be managed. Rather than directly regulate runoff, the federal government has delegated the authority to implement the Clean Water Act to the Department of Ecology in Washington State. The Department of Ecology required WSDOT to get municipal water quality permits in 1995.

The municipal permits are called the Phase 1 National Pollutant Discharge Elimination System (NPDES) Permits for Municipal Separate Storm Sewer Systems.

The Clean Water Act also requires WSDOT to get permits from the Department of Ecology to protect water quality on construction projects. These permits ensure that adequate precautions are taken to prevent erosion and spills from contaminating adjacent waters.

There are two types of Construction National Pollutant Discharge Elimination System (NPDES) Permits. Individual permits are required for the largest, highest-risk projects. General permits are used for routine projects.

What do municipal stormwater permits require?

The municipal stormwater permits require that highways be designed and maintained to minimize pollution and potential damage to downstream properties. Among other things, the permits require WSDOT to:

- Build stormwater treatment facilities to clean runoff.
- Maintain highways to keep runoff clean.
- Monitor program effectiveness in eliminating pollution.

- Coordinate with others to develop watershed-scale solutions.
- Prevent construction projects from polluting water.
- Educate employees and others how to protect water quality, and
- Track stormwater-related expenses.

What areas are covered by the Municipal Stormwater Permits?

WSDOT has permits that cover King, Pierce, and Snohomish Counties (See Exhibit 1-1). The permits are named after Water Quality Management Areas, as defined by the Department of Ecology that do not perfectly coincide with county boundaries. The permits cover the following Water Quality Management Areas:

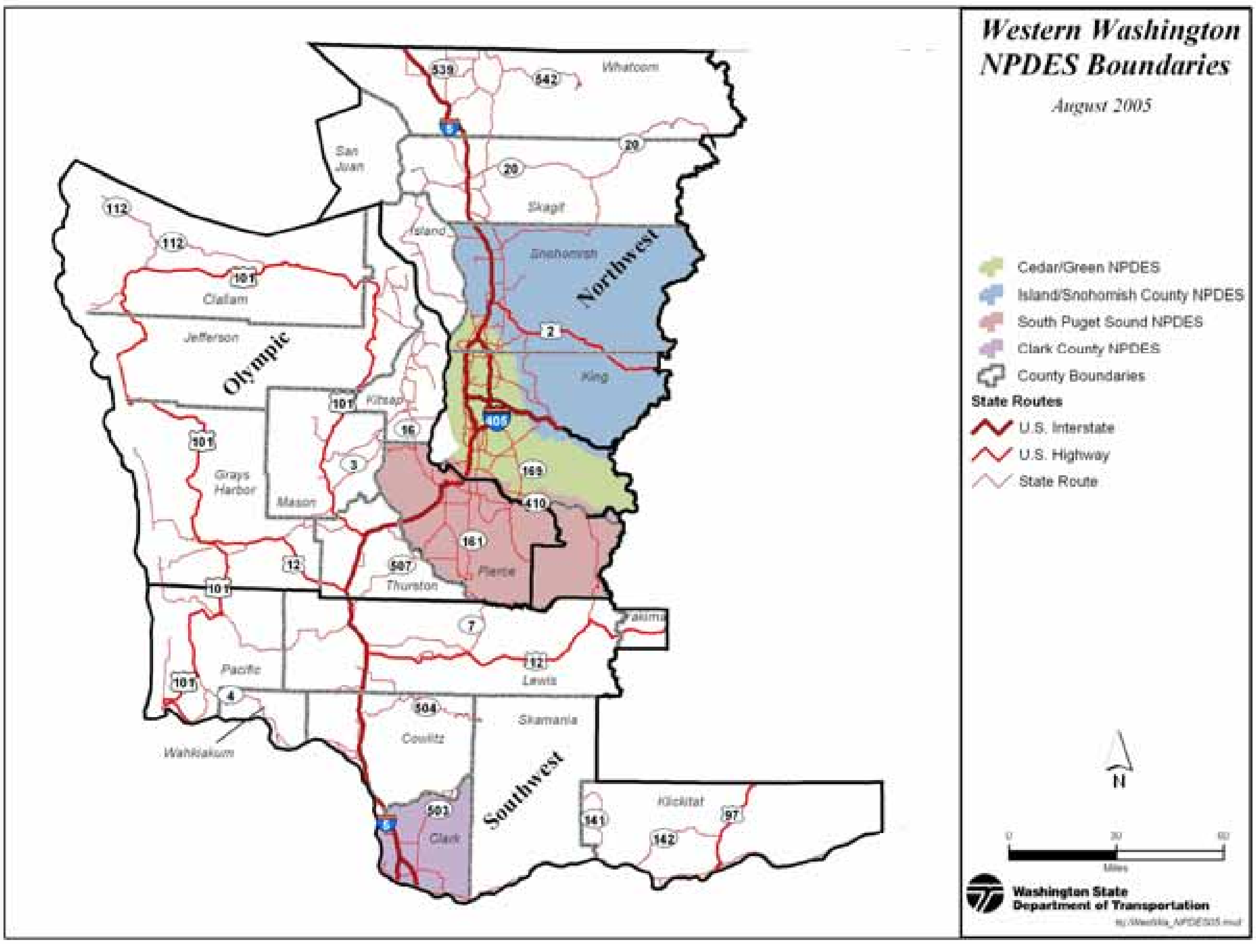
- The Cedar-Green Water Quality Management Area, permit number WASM 10001.
- The Island Snohomish Water Quality Management Area, permit number WASM 20001.
- The South Puget Sound Water Quality Management Area, permit number WASM 30001.

As it was initially presumed that Clark County would also require a permit, WSDOT has also reported on stormwater-related activities in Clark County.

What is the status of the permits?

The three permits were initially scheduled to expire on July 5, 2000 but Ecology has not yet re-issued the permits. To avoid a lapse in permit coverage, Ecology has extended the above referenced permits, continuing current permit requirements until the next permits are issued. Therefore, the 1995 permit requirements remain in effect at this time. It is anticipated that new permits will be issued in late 2006 or 2007.

Exhibit 1-1
Municipal Stormwater Permit Areas



What is WSDOT's strategy for managing stormwater?

WSDOT prepared a Stormwater Management Plan in 1997 that outlines the long-term strategy for protecting water quality (WSDOT 1997). This plan describes how WSDOT will comply with federal and state laws (40 CFR 122.26, RCW 90.48 and

WAC 173-220) and permit conditions. WSDOT routinely updates the plan to keep current with changing regulations.

Chapter 2 Stormwater Program Priorities and Associated Costs

What are WSDOT's priorities in managing stormwater?

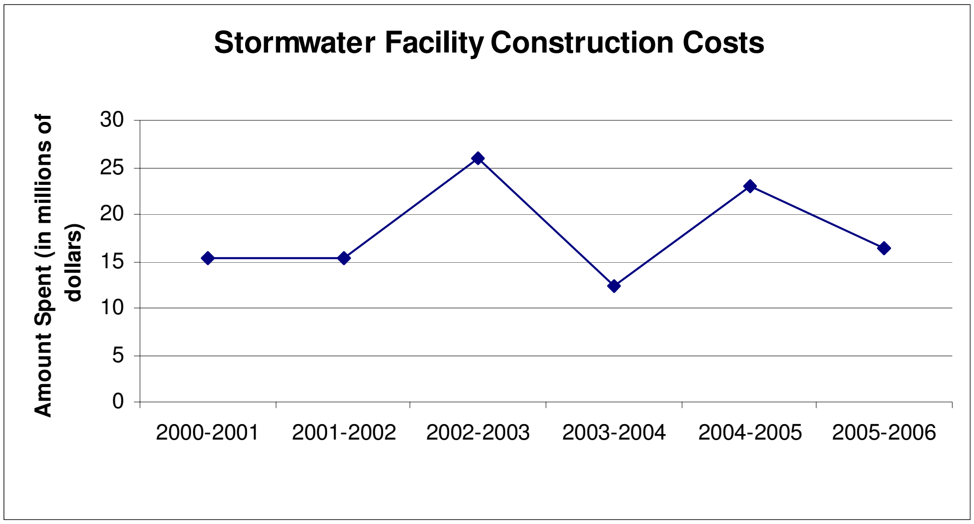
Consistent with the Stormwater Management Plan (SWMP), the following activities continue to be high priorities for WSDOT. The associated costs for priority activities are included in this section in descending order of costs. Each activity is described in further detail in subsequent report sections.

Stormwater treatment facilities are referred to as Best Management Practices (BMPs) in this report. WSDOT's most commonly used BMPs are ponds and wide grass ditches called bioswales.

Stormwater Treatment Facilities Construction: WSDOT's top stormwater management priority is to ensure that ongoing highway projects meet requirements for maintaining the existing quality of our state's waters. The cost of building stormwater treatment facilities, known as Best Management Practices (BMPs), in conjunction with highway construction projects exceeds all other stormwater management costs combined. Detailed information on stormwater treatment BMP construction is provided in Section **7**.

Stormwater treatment BMP construction costs are linked to the amount of highway construction that occurs each year. Fluctuations in stormwater BMP construction costs as shown in Exhibit 2-1 reflect fluctuations in the amount of funded construction, <u>not</u> a wavering in WSDOT's commitment to provide stormwater treatment.

Exhibit 2-1

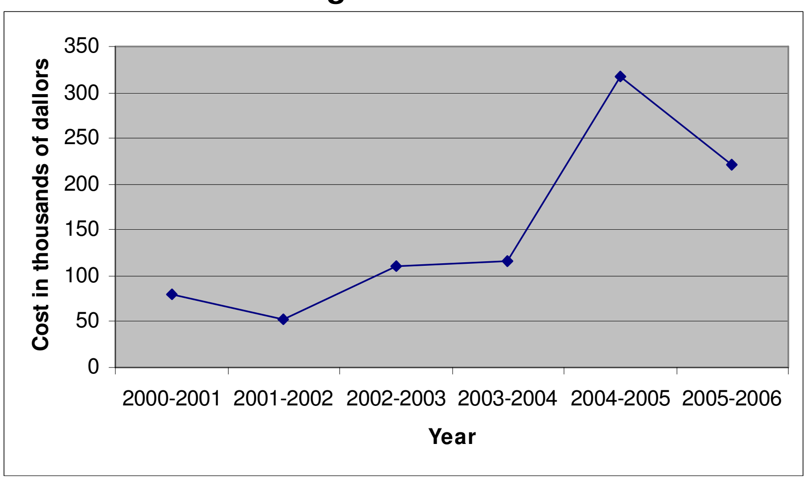


Operations and Maintenance: Operations and maintenance programs are essential to maximizing roadway safety, prolonging the life of highways, and ensuring that stormwater BMPs perform at maximum efficiency. In 2005-2006, WSDOT spent $11,109,000 on maintenance activities that protect water quality statewide. Detailed maintenance program information is included in Section 3.

Stormwater Utility Fees: WSDOT pays stormwater utility fees to utility districts that receive runoff from highways. These fees are used to construct new stormwater treatment facilities and maintain the local stormwater systems that convey and treat highway runoff. Current trends related to utility fees include: 1) fewer municipalities are charging fees as fewer areas now lack treatment facilities and 2) utilities fee rates are increasing where new BMPs are required. During this reporting year, WSDOT paid $729,769 in stormwater utility fees.

Stormwater Monitoring and Research: Monitoring and research are necessary to 1) determine where treatment is most needed, 2) determine the effectiveness of treatment, and 3) find better ways to clean the water. Detailed monitoring and research program information is provided in Section 6. Monitoring efforts have substantially increased in recent years and the gathered data has greatly increased our understanding of how effectively stormwater treatment BMPs remove different types of pollutants. Exhibit 2-2 shows WSDOT's recent increases in stormwater monitoring costs.

Exhibit 2-2
Stormwater Monitoring Costs



WSDOT purchased a substantial amount of new monitoring equipment in 2004-2005 in order to increase monitoring efforts. While monitoring expenditures decreased in 2005-2006 compared to 2004-2005, more data was collected.

The research program focuses on, 1) more accurately determining treatment needs, 2) improving the effectiveness of existing BMP designs, and 3) developing new methods for cleaning stormwater, especially Low Impact Development approaches. Research is performed in partnership with state universities, the Department of Ecology, and the Federal Highway Administration. An estimated $168,000 was spent on research in the current reporting period. Since 2000, WSDOT has spent $1,878,000 on stormwater-related research.

Low Impact Development is a name for strategies to keep stormwater spread out so that it can be treated naturally.

Watershed-based mitigation: Sometimes there is no available land along the highway to build stormwater treatment BMPs and little potential to provide a significant benefit to the environment. Such cases often include highways that are completely surrounded by hospitals, schools, strip malls or other buildings, and where the nearest streams have long ago been buried in pipes that can't possibly provide habitat for fish or wildlife. In such cases, public funds can provide a much greater environmental benefit by improving the conditions in nearby areas that still have available land for installing treatment BMPs and habitat to protect.

Information on WSDOT's watershed-based mitigation program is provided in section 5.

Stand-Alone Stormwater retrofit: Most of Washington's highways were built before the Clean Water Act was created and have no stormwater treatment BMPs. WSDOT fixes or "retrofits" these older locations by building ponds and other treatment facilities. When feasible, outfalls are retrofitted in conjunction with new construction projects. In other cases, BMPs are built as stand-alone projects. To date, however, funding for stand-alone retrofit projects has been limited. In this reporting period $206,000 was spent on stand-alone retrofit projects.

Outfalls are locations where stormwater runoff, treated or untreated, leaves the WSDOT right of way or enters a nearby waterbody.

Exhibit 2-3
Stand-Alone Stormwater Retrofit Expenditures

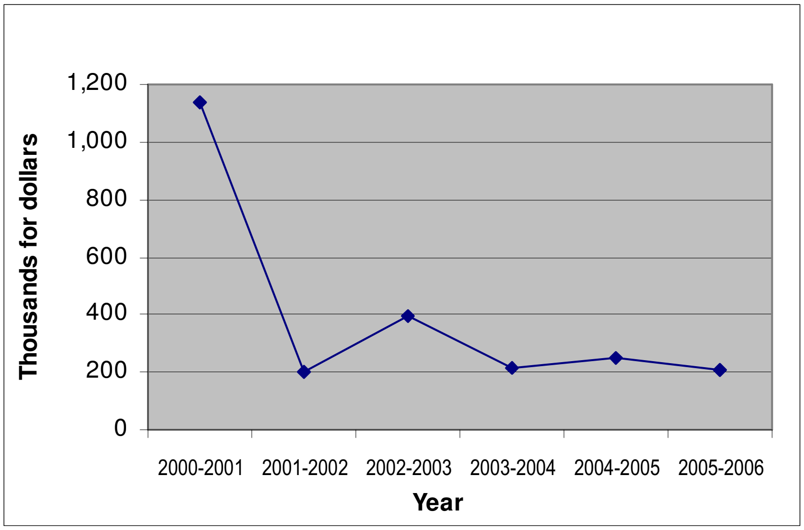


Exhibit 2-3 reflects a temporary increase in funding in the 1999-2001 transportation budget. Another increase in retrofit expenditures is expected over the next few years because the Legislature funded $3.8 million dollars for stand-alone stormwater retrofit projects in 2005. Design work for those projects is currently under way.

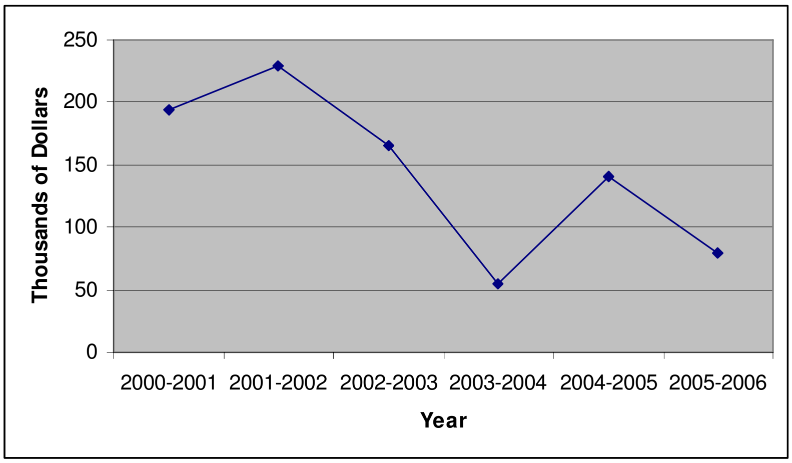
Policy and training: WSDOT's designers and builders need clear policies and training in order to make the right decisions on how best to protect water quality. Stormwater policies and design guidelines are provided in the *Highway Runoff Manual* and *Hydraulics Manual.* To keep up with changing regulations and evolving technologies, WSDOT has updated the *Highway Runoff Manual*, which provides policies and design criteria for stormwater treatment (WSDOT 2006). The cost of updating the *Highway Runoff Manual* in this reporting period was approximately $180,000. Training programs on how to apply those manuals has been developed and classes are provided to design staff.

Updating the *Highway Runoff Manual* involves much more than simply updating content. Extensive studies are required in support of policy changes and design criteria modifications.

Erosion and Sediment Control: The erosion and sediment control program helps WSDOT keep construction project runoff clean. This is accomplished by, 1) training designers and builders, 2) providing design and contract standards, 3) inspecting construction projects, and 4) tracking water quality data collected during storms. Costs shown below do not include the actual costs to perform erosion control work in the field or to monitor water quality. Those costs are completely integrated with other construction costs and can't readily be tracked at this time. More detailed Erosion Control Program information is presented in section 4.

Is important to acknowledge that erosion control training costs decreased in recent years because 1) contractor training organizations that have agreed to teach WSDOT's erosion control curricula at no cost to WSDOT and 2) the Department of Ecology began overseeing contractor training in 2005. For more information on WSDOT training programs see http://www.wsdot.wa.gov/environment/wqec/erosion.htm

Exhibit 2-4
Erosion Control Training, Inspections and Performance Tracking Costs



Stormwater Permit Fees: WSDOT pays stormwater permit fees to Ecology each year for municipal and construction stormwater permits to cover permit program costs. This year WSDOT paid $36,294 in municipal stormwater permit fees and $73,000 in construction stormwater permit fees.

What are WSDOT's other stormwater management priorities?

Other important activities that were identified in the Stormwater Management Plan (WSDOT 1997) as medium or low priority are listed below. While WSDOT is actively

Progress associated with maintenance-related priorities described in Section 3.

working to address these issues as resources allow, the costs associated with them are not individually tracked.

- Supporting education programs.
- Determining maintenance requirements for treatment BMPs.
- Developing a statewide tracking system for treatment BMP construction.
- Identifying illicit discharges,
- Developing a tracking system for operations and maintenance activities.
- Monitoring operations and maintenance practices relative to water quality impacts, and
- Developing budgetary mechanisms to fund maintenance activities associated with water quality improvements.

What other WSDOT activities benefit water quality that are not stormwater permit requirements?

While not specifically established to reduce water quality impacts, the following programs benefit water quality by reducing the amount of pollutants that are generated or by preventing pollutants from entering stormwater.

For more information on the benefits of the Commute Trip reduction program see http://www.wsdot.wa.gov/tdm/program_summaries/ctr_summ.cfm

Trip reduction program: This program kept approximately 20,000 cars off the road each day in 2005. Getting those cars off of the roads prevented them from directly depositing pollutants onto roadways and reduced emissions by an estimated 3,700 tons. As air pollution is a contributor to stormwater pollution, this program helps reduce pollutants as the source. The program also reduces the need for additional highway construction.

Litter cleanup and the Adopt a Highway program: WSDOT spends approximately $2 million to clean up each year. For example, in 2003-2004, WSDOT cleaned up 5,359 tons of litter. This program prevents trash from entering our waterways and fosters greater environmental awareness and a sense of stewardship among thousands of volunteers.

For more information on WSDOT's litter cleanup programs see http://www.wsdot.wa.gov/maintenance/roadside/litter.htm

Chapter 3 Maintenance and Operations

How do maintenance activities affect water quality?

Most maintenance activities simultaneously increase safety, extend roadway life, protect water quality and habitat. For example, cleaning drainage culverts prevents flooding that can damage highways and cause accidents. Additionally, cleaning culverts prevents sediment and debris from entering streams and fish habitat. Such maintenance activities are important components of WSDOT's overall program for protecting water quality.

Most maintenance activities that keep highways clean and safe also protect water quality.

Some essential maintenance activities are carefully controlled to avoid negative water quality impacts. Examples include the application of deicing materials and herbicides. In accordance with the Stormwater Management Plan, WSDOT:

- Reports on highway sweeping activities and BMP maintenance.
- Estimates volumes of ice and snow control material used, pesticides and fertilizers applied to roadsides, and reports on research activities associated with those materials.
- Implements Integrated Vegetation Management Plans.

- Tracks and eliminates illicit discharges i.e., dumping of polluted water into our stormwater systems, and
- Tracks hazardous material spills.

What has happened in the current reporting period relating to these maintenance activities?

Road, drainage system and stormwater treatment BMP cleaning: As stormwater flows over pavement and road shoulders as well as through catch basins, culverts, ditches, ponds and vaults, it is important that these structures be cleaned. Cleaning these structures, 1) prevents trash, debris and accumulated sediments from entering state waters, 2) controls flow volumes and velocities by removing trash, debris, and accumulated sediments, 3) maximizes treatment system effectiveness, 4) prevents harmful roadway flooding, and 5) protects drivers by keeping road surfaces clean and safe.

Maintenance activities prevented the pictured materials from entering waterways in the Tumwater area.

Exhibit 3-1 shows the costs associated with these cleaning activities on a statewide basis. WSDOT has switched to reporting on these activities on a statewide basis rather than by permit areas only because the permit areas do not directly correspond to areas for which maintenance tracks costs. This switch will ensure a higher level of accuracy in reporting. As the future municipal permit is anticipated to cover most of the state, statewide tracking is the direction that WSDOT plans to report in the future.

Exhibit 3-1
Drainage and Stormwater Treatment System Maintenance

Management strategy	Activity	Cost
Reduce pollutants from entering drainage systems	Sweeping	$3,433,000
	Shoulder buildup removal and regrading	$1,144,000
	Jersey scupper cleaning	$54,000
Maintain drainage systems to keep water clean as possible and to prevent system failures.	Ditch cleaning	$3,0620,00
	Catch basin inspection, cleaning and repair	$1,650,000
	Culvert inspection, cleaning and repair	$1,686,000
Maintain treatment facilities to ensure optimal performance.	Pond maintenance	$64,000
	Vault maintenance	$16,000
Total		$11,109,000

The most efficient means of keeping drainage systems clean and to ensure the effectiveness of stormwater treatment systems is to minimize the amount of sediment entering them. To that end, the bulk of cleaning costs are spent on sweeping road surfaces and cleaning out catch basins that trap sediment at the entrances of storm drains. These activities reduce the need to clean all other drainage and treatment structures. Even when road surfaces and catch basins are cleaned, road shoulders, ditches and culverts still need periodic cleaning to ensure optimal function.

Specifications created by the Pacific Northwest Snowfigthers help to standardize the market for anti-icing chemicals, resulting in better pricing and availability of more environmentally friendly de-icing chemicals.

Ice and Snow: WSDOT belongs to a consortium of six Northwest states and Canadian provinces known as the Pacific Northwest Snowfighters (PNS) Association. One of the PNS's main priorities is to develop anti-icing chemical specifications for use by all member organizations. These specifications require that anti-icing chemicals are environmentally safe (i.e., must meet heavy metal and fish toxicity standards) before they can be considered for use. All products currently used by

WSDOT for winter maintenance meet these criteria.

Exhibit 3-2 shows the quantities and costs of deicer materials used in the current reporting period. Exhibit 3-2 also shows the cost of sand cleanup activities and the amount of sand recovered. However, WSDOT is moving away from sand use on their roadways to a chemical deicer program that will minimize sediments leaving the highways.

Exhibit 3-2
Deicer Quantities Used in the Winter of 2005-2006 and Sand Cleanup Costs

De-Icer Material	**Quantity**	**Cost**
Sand	37,785 Tons	$288,052
Sand Cleanup	Not accurately measurable	$861,000
Solid Deicer	30,009 Tons	$3,298,602
Liquid Deicer	4,082,059 Gallons	$2,421,621
Total Dollars Statewide		**$5,896,378**

Integrated Vegetation Management: WSDOT increasingly uses the Integrated Vegetated Management (IVM) approach to manage the vegetation that grows along highways. In accordance with the IVM approach, WSDOT controls undesirable roadside vegetation while establishing stable, low maintenance plant communities. This approach gradually improves the overall health of the roadside while reducing long-term maintenance costs and minimizing herbicide use.

For more information on WSDOT's Integrated Vegetation Management Program see http://www.wsdot.wa.gov/maintenance/vegetation/

Undesirable vegetation includes vegetation that spreads onto pavement and around roadside structures, noxious and nuisance weeds, and trees and brush that encroach on traffic operations.

Uncontrolled vegetation can quickly hide traffic signs, light poles, fog lines and guard rails, which are essential for protecting drivers.

Such plants create safety hazards, can damage the roadway and can create problems for surrounding land use and agriculture.

As vegetation varies greatly across the state, local IVM plans are being developed for each maintenance area. The plans require maintenance crews to take extra precautions for protecting water quality in sensitive locations. IVM plans have been completed for the King, Pierce, and Snohomish counties. The plan for Clark County will be completed in spring of 2007 along with plans for all remaining areas and counties in the state. WSDOT anticipates herbicide use will gradually decrease as plans are implemented.

Noxious weed control is required by federal and local laws.

When water sheets evenly off of the road, pollutants are filtered out of the water in the grass. When vegetation encroaches on to the pavement, however, water can't drain evenly.

Herbicide use is tracked by, 1) location and date, 2) herbicide used by trade name, 3) total amount used, and 4) number of acres treated. Exhibit 3-3 is a summary of the acres of WSDOT property treated and quantities (pounds of active ingredient) used, by county for the 2005 calendar year.

Exhibit 3-3

Herbicides Used and the Number of Acres Treated in NPDES Permit Counties – 2005

County	Number of Products Used	Pounds of Active Ingredient Used	Acres Treated
Clark	18	445	252
King	22	2,714	1,546
Pierce	15	799	353
Snohomish	11	971	423

The pounds of herbicide used within the permit areas decreased in all counties except King, which increased 3.6% from 2004. Overall, the acres treated decreased by 34% within the permit

WSDOT increased herbicide use in King County in response to an increased focus on noxious weed control by the King County Noxious Weed Control Board.

areas. The decrease in acres treated as it relates to pounds of herbicide applied is a result of more selective, spot applications to kill individual plants. In the past more of the weed control applications were made with a blanket spray covering more total area.

What are illicit discharges, why are they important, and what does WSDOT do about them?

Adjacent landowners are not allowed to dump untreated stormwater or polluted wastewater into WSDOT's stormwater system. Such dumping of polluted water is known as illicit discharges. It is important that illicit discharges be eliminated because WSDOT's stormwater treatment systems are sized to treat runoff from highways only. Adjacent land owners are responsible for preventing pollution or treating their own water before it leaves their property. In last year's report 3 locations were suspected of receiving water from illicit discharges. Further investigation, however, has since revealed that the three locations are not receiving illicit discharges.

Example of why we care about illicit discharges: High flows of muddy water from a nearby construction site severely eroded this bioswale, destroyed a stormwater monitoring station, partially filled a treatment pond with mud, and made WSDOT's runoff dirty.

In this reporting period three new illicit discharges were identified within the permit areas. While WSDOT doesn't have regulatory authority over its neighbors, WSDOT takes whatever steps it can to prevent the tainted water from entering its drainage system and notifies the Department of Ecology when assistance is required. Exhibit 3-4 describes the illicit discharges and actions taken to eliminate them.

Exhibit 3-4

Detected Illicit Discharges and Corrective Actions Taken

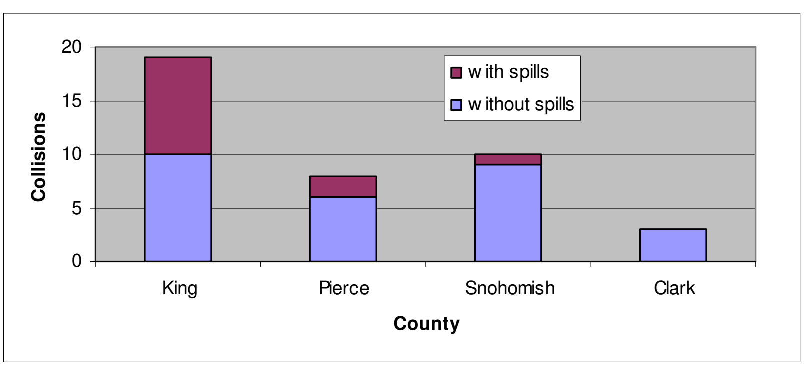
Location	Pollutant type	Action taken	Results
Snohomish County Highway 531	Sediment from nearby business entering bioswale	Directly contacted business	Business agreed to sweep their lot to prevent tracking of mud onto the highway
Clark County Highway 14	Sediment from nearby construction	Problem reported to Ecology for investigation	Ecology is working with the discharger.
Clark County Highway 14	Sediment from nearby construction	Problem reported to Ecology for investigation	Ecology is working with the discharger.

As WSDOT doesn't have regulatory authority over adjacent land owners, WSDOT must sometimes ask the Department of Ecology to help correct illicit discharge problems. An Ecology inspector was asked to take the lead in eliminating the problems on Highway 14 because the water was coming from nearby sites with stormwater permits from Ecology.

Hazardous Material Spill Tracking: WSDOT tracks the number and location of collisions and spills involving hazardous materials. Data collected in July 2005 through March 2006 (the most recent date for which data has been compiled) is presented in Exhibit 3-5, which includes a breakdown of collisions by county. Collision data is used to prioritize safety improvement projects that can help reduce future accidents.

Exhibit 3-5

Collisions Involving Hazardous Material Spills in Permit Areas between July 1, 2005 and March 31, 2006



Rear-end collisions caused 1/4 of hazardous materials spills. The high percentage of rear-end collision related spills suggests that practicing safe driving habits like allowing for adequate braking distance and giving trucks adequate space could substantially reduce collision-related spills.

Whenever a collision results in a spill, WSDOT or the State Patrol notify Ecology's spill response crews who immediately go to the site, identify the spilled substance, determine how much was spilled, and direct cleanup activities as appropriate. Ecology's spill response crews have the expertise to accurately identify and measure spills, as well as the ability to document the effectiveness of cleanup activities. For this reason, detailed spill information is best tracked by the Department of Ecology.

Sensitive Area Mapping: WSDOT has mapped and marked all environmentally sensitive roadsides so that maintenance crews can better protect streams, wetlands, and other water bodies. Each maintenance area has an atlas along with tabular data for their respective highway sections in which all sensitive aquatic areas within 300 feet of the right-of -way are identified. Crews installed Sensitive Area Markers in accordance with the atlases and/or tabular data, and according to WSDOT Maintenance Program protocol.

Sensitive area mapping is not a municipal stormwater permit requirement. As mapping streams, wetlands and other waters helps WSDOT better protect water quality, however, information on the program is included in this report.

The Sensitive Area Markers consist of solid green flexible guideposts with eight inch white reflective tape at the top. Below the white tap is a second piece of reflective tape. The coral salmon sticker is the first reflective tape and indicates that the location is within 300 feet (approximate, buffer) from the beginning or closest point where the highway approaches a waterway. Approximately 300 feet past the end of the segment is another green guidepost with a green tape reflector (to designate the end of the 300 foot buffer) below the already attached white reflector. Exhibit 3-6 contains examples of installed Sensitive Area Markers.

Sensitive Area Markers containing salmon stickers are called "fish sticks" by maintenance crews as they indicate where special precautions are necessary to protect fish. Water quality is only one of the environmental issues that maintenance crews must address. When it comes to protecting endangered runs of salmon and steelhead, however, water quality is a major concern.

Exhibit 3-6

Example of Sensitive Area Markers. Markers on both sides of Coldwater Creek show maintenance crews where the sensitive area begins and ends.

A Best Management Practice (BMP) Field Guide for Endangered Species Act (ESA) § 4(d) Habitat Protection (March 2004) has been developed and distributed to every maintenance worker and vehicle. The guide is intended for WSDOT maintenance crews and regional maintenance environmental coordinators who work within sensitive priority areas. The guide was developed to train and alert staff as to when and where special precautions must be taken to protect water quality, sensitive species habitats, and public safety. Maintenance personnel report any discrepancies found in the field so that map quality can be continuously refined. These discrepancies are forwarded to a biologist for review and concurrence prior to updating data.

Chapter 4 Construction Site Erosion Control

Why is erosion control important on highway construction projects?

The movement of soil by water and wind is called erosion and bare soil erodes faster than soil covered with plants. As large highway construction projects expose and move large amounts of soil, they greatly increase the potential for erosion. Severe erosion increases the costs and time needed to complete highway construction projects. It also damages adjacent properties, makes our waters muddy, and hurts fish.

The natural erosion rate is close to 1 inch per 1,000 years; a single storm, however, can remove more than an inch of soil from a poorly managed construction site.

What is the purpose of WSDOT's Erosion Control Program?

The purpose of WSDOT's Erosion Control Program is to minimize construction site erosion. Benefits of good erosion control include cleaner water, reduced construction costs and delays, and reduced risk of damage to adjacent properties. To continually improve erosion control performance WSDOT:

- Trains its designers, inspectors, and construction contractors how to prevent erosion.
- Has specialists that can provide technical assistance to construction staff.

Historically, construction projects were a significant source of erosion. Proper erosion control however, reduces construction site erosion by more than 95%.

- Develops contracts to ensure that construction contractors provide effective erosion control.
- Performs statewide erosion control inspections.
- Monitors water quality at select high risk sites, and
- Notifies the Department of Ecology when problems occur so that their inspectors can provide additional support.

How does WSDOT prevent erosion?

Construction stormwater permits require WSDOT to create Temporary Erosion and Sediment Control (TESC) plans. These plans establish when and where specific BMPs will be implemented to protect water quality. WSDOT has developed a program to ensure that quality TESC plans are consistently designed and implemented on construction projects.

Erosion control BMPs include structural devices like settling ponds, maintenance procedures like sweeping dirt off of roadways, and managerial practices like limiting major earthwork to the dry season. These BMPs are used in combination to prevent erosion or remove mud from water.

How does WSDOT prepare people to effectively prevent erosion?

All WSDOT design and construction staff who either write or implement TESC plans attend WSDOT's *Construction Site Erosion and Sediment Control Course* every three years. This course ensures that everyone with erosion control responsibilities know the latest methods, products, and procedures for preventing erosion. During the 2005-2006 reporting period, approximately 285 WSDOT employees were trained in erosion and sediment control. Construction contractors' designated Erosion and Sediment Control (ESC) Leads are required to become certified in erosion and sediment control by attending training provided by a Department of

Ecology approved training organization. In the fall of 2005, when all major earthwork projects were inspected, it was determined that all contractor ESC leads were currently certified.

How does WSDOT ensure that adequate TESC plans are prepared?

Trained designers create plans that include all of the BMPs needed to prevent erosion. To ensure that all construction contractors are given clear guidance on how to implement the plan, WSDOT creates standardized instructions in contracts called Standard Specifications. Other, more specific contract specifications are prepared for projects that require unique solutions.

To ensure that the most effective, reliable erosion control products are used, new products are routinely evaluated. Products that meet WSDOT's specifications are added to a master list of approved materials called the Qualified Products List. Designers and builders can more quickly identify and buy quality products when they are on the list.

WSDOT's new tool for creating TESC plans is being deployed throughout the state. This tool assists designers in preparing more complete and contractually enforceable plans by ensuring that all possible factors are considered and that adequate instructions are included in contracts. WSDOT also has erosion control specialists who help designers find solutions to unusually difficult challenges.

WSDOT defines projects as high risk for erosion when they involve more than 5 acres of soil disturbance; discharge to nearby state waters; and meet at least three of the following four characteristics:

- **More than half of the site consists of soils that don't let water soak in.**
- **The project involves wet-season work or lasts more than one year.**
- **Cut/fill slopes exceed more than 50 feet in length.**
- **There are seeps or a high groundwater table**

How does WSDOT verify that TESC plans are properly implemented?

Every fall WSDOT inspects all projects that pose moderate and high risks of erosion. In 2005, 21 projects were inspected to determine how well they were prepared for the rainy season.

Moderate risk projects discharge to state waters but do not meet the high risk criteria.

Preparedness was judged based on how thoroughly the contract specifications were implemented and, if large storms have already occurred, how effectively the plan prevented erosion. Whenever plan inadequacies were discovered, technical assistance was provided to ensure that the projects were fully prepared for wet weather.

How well is WSDOT doing and how can we do better?

WSDOT performs a "Fall Assessment" each October to see how well WSDOT projects were prepared for rainstorms during the fall of 2005 compared to their level of preparation in 2003 and 2004, summarized in Exhibit 4-1. Performance for eleven of the thirteen TESC measures improved or remained stable at a high level. The biggest improvement was in maintaining BMPs. Performance decreased for two measures. Access route stabilization, which prevents the tracking of mud from construction sites onto nearby streets, decreased due to eastern Washington projects that hadn't yet installed rock stabilized entrances. The other measure, protecting cut and fill slopes, possibly decreased due to dry October weather allowing construction of cut and fill slopes to extend later in the season. Based on these results, WSDOT will focus its planning, contract enforcement, and training efforts to correct identified deficiencies, and focus on those measures in the "Poor" and "Fair" categories.

Exhibit 4-1 summarizes how well projects are prepared for fall rains before the really wet weather begins. This is done so that projects have time to fix any deficiencies before the heavy winter rains begin.

Exhibit 4-1

Erosion and Sediment Control Assessment Results

Assessment Measure		2003	2004	2005	2004 to 2005 Status
Excellent	Control other pollutants from impacting water quality	**	100%	100%	stable
	Dewatering	71%	100%	100%	stable
Good	Delineate clearing limits	100%	100%	95%*	stable
	Control flow rates	84%	100%	95%*	stable
	Sediment control BMPs installed on time	90%	100%	95%*	stable
	Manage project erosion/sediment control BMPs proactively	75%	80%	90%	improved
	Channels for temporary stormwater conveyance are stabilized	64%	73%	87%	improved
	Storm drain inlet protection	82%	83%	86%*	stable
	Erosion control BMPs installed on time (stabilize soils)	**	67%	86%	improved
	Access routes prevent tracking of mud onto streets	69%	91%	82%	decreased
Fair	Protect cut & fill slopes	50%	89%	79%	decreased
	Amount of disturbed soil covered with erosion control BMPs	45%	65%	70%*	stable
Poor	Maintain BMPs	70%	50%	67%	improved

***Stable performance status was achieved for all measures that remained within 5% of the previous years' rating.**
****Two new categories have been added since the 2003 report.**

How well does WSDOT keep dirt out of water?

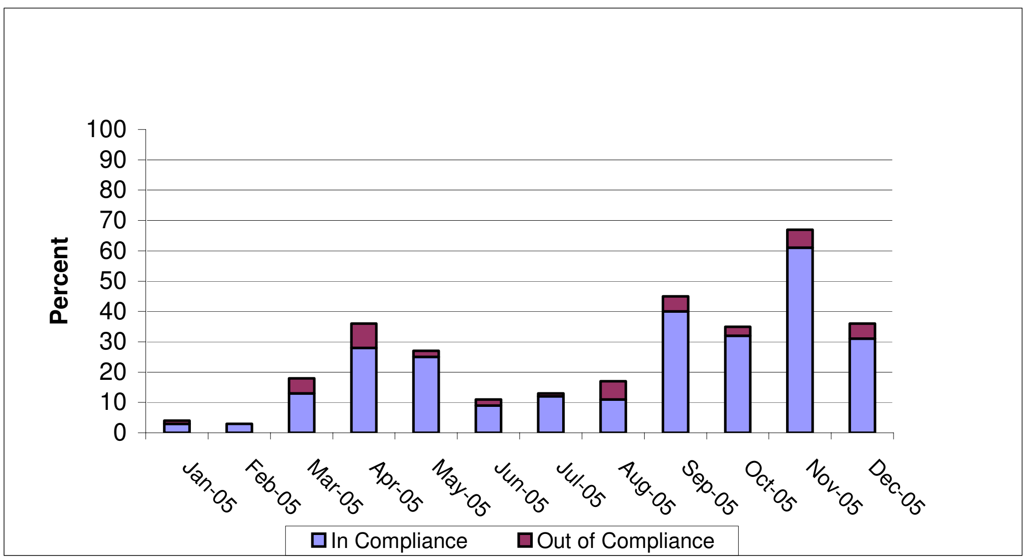
WSDOT completed its third year of construction site water quality sampling under a statewide monitoring policy that requires monitoring on at least 20% of all projects with substantial potential for water quality impacts. Samples are collected on projects during times when compliance with state standards is the most challenging, like during in-water work and rainstorms.

In-water work includes any construction activity that occurs below the ordinary high water mark.

Exhibit 4-2 summarizes statewide monitoring results comparing water quality upstream and downstream from 15 projects. Eighty-six percent (268 out of 312) of the collected samples met water quality standards for water clarity. Of the 44 non-complying events, 8 were associated with permitted in–water activities. The remaining events were associated with large storms (16), inadequate preparation (14), construction team mishaps like leaking hoses (4), and muddy run-on from neighboring properties (2). In all cases, monitoring results prompted corrective actions to restore compliance with water quality standards.

In comparing Fall Assessment results to water quality monitoring data, we find that projects demonstrating poor performance in two or more assessment measures are likely to experience water quality problems during the winter months unless deficiencies are corrected.

Exhibit 4-2
Statewide Water Quality Monitoring Results



How does WSDOT respond to erosion problems?

WSDOT has formal notification procedures to ensure that water quality problems are properly recognized, reported to the Department of Ecology, and corrected to eliminate environmental permit violations. Any time WSDOT staff notice that water quality doesn’t meet standards or any other environmental requirement is not met, they are required to notify both WSDOT management and Ecology. The procedures ensure that technical experts within WSDOT and Ecology are aware of the problems and can provide prompt support. The procedures also ensure that lessons learned on one project are applied to all others.

Chapter 5 Watershed–Based Treatment

What is a watershed-based treatment approach?

A watershed-based treatment approach is an alternative to building ponds and other treatment facilities at the edge of the highway. Using a watershed approach, WSDOT studies a large area around the road project, assesses conditions in the watershed, identifies the wetland and stream restoration opportunities, prioritizes opportunities to mitigate stormwater impacts, and mitigates at the location where WSDOT can do the most good. Watershed-based treatment restores degraded lands so they can function naturally to the benefit of the entire watershed. Watershed based mitigation may include the restoration of a previously drained wetland, reforestation, stream channel restoration, or removal of impervious structures that have outlived their usefulness.

The watershed approach allows a project proponent to look beyond the limits of the project itself in order to best address project impacts. Locations for stormwater treatment, for instance, can be selected that provide the greatest benefits to the entire watershed. Larger tracks of land away from the highway are often available where WSDOT can provide greater benefits, preserve open space, and provide valuable wildlife habitat at lower costs than WSDOT can achieve using the limited pieces of land along highways.

When is watershed-based treatment a better way to protect our state's waters?

The watershed-based approach is used when it isn't possible or cost effective to mitigate stormwater impacts along the edge of the highway. For instance, it may not be feasible to build ponds next to an urban highway that is completely surrounded by office buildings, schools or hospitals. Likewise, rural

The watershed approach also minimizes impacts to humans. Land is $200 a square foot in downtown Seattle and highly populated. Taking that land to build stormwater BMPs is disruptive to communities and expensive.

highways often pass through rugged terrain, wetlands or areas with a high groundwater table that make it impossible or extremely expensive to treat stormwater at the highway's edge. In these cases, a watershed approach provides new cost-effective options for design engineers.

Where has a watershed approach been used?

WSDOT's watershed approach adapted tools developed originally at the Department of Ecology. Tools were first adapted and tested on a project on SR 522 in Snohomish County. Later, implementation and methods refinement were completed on the North Renton segment of I-405, parts of I-405 and SR 520 near Bellevue and Kirkland, and on SR 167 through the Kent/Auburn valley. Results of these characterization efforts are available for review at: http://www.wsdot.wa.gov/environment/watershed/technical_report.htm.

The methodology continues to generate interest from local governments, other state agencies, other states, and the federal government. The "Operational Draft Methodology" document is available at: http://www.wsdot.wa.gov/environment/watershed/docs/methods.pdf

Why hasn't WSDOT used the watershed-based treatment all along?

Stormwater regulations were originally established that required water to be treated on the property where it was generated. This straightforward approach ensures that each landowner take responsibility for their own water. While watershed–based mitigation can often yield larger benefits at lower costs, it is much more difficult to prove the level of benefits associated with natural approaches than with engineered facilities. WSDOT and the Department of Ecology are working in partnership to develop guidelines for when and where a watershed–based treatment can be trusted to fully offset the impacts of highway construction projects.

How is WSDOT working to expand watershed-based treatment options?

Presently, only wetland or stream restoration upslope of a stormwater outfall is allowed. Discussions have begun with the Department of Ecology to develop a watershed-based stormwater flow control strategy that would allow WSDOT to restore sites both upstream and downstream of a highway.

At present, only stormwater flow can be addressed though a watershed approach. Water quality impacts still need to be addressed on-site. Future watershed-based tools can and hopefully will be developed cooperatively with Ecology to address water quality where conventional treatment is not feasible or cost effective.
WSDOT continues to work directly with the Department of Ecology to develop and refine new, innovative tools for treating stormwater runoff from state highways. WSDOT works with interagency technical groups, representing state, federal, and local governments, to develop and integrate watershed-based tools that help plan for future growth in Washington State. WSDOT also continues to provide outreach and share data with watershed groups and planning entities when working on transportation projects.

In addition to working with regulatory agencies to expand watershed-based treatment options, WSDOT also developed a transportation project screening tool. This tool helps transportation planners identify proposed projects that may benefit from the application of watershed-based mitigation, including stormwater flow control mitigation.

Chapter 6 Stormwater Treatment Effectiveness Testing and Research

Why does WSDOT monitor the quality of stormwater runoff?

WSDOT is required by the Clean Water Act and Washington State Regulations to use "all known and reasonable methods of prevention, control and treatment" to protect our State's waters. When such steps are taken, it is presumed by regulatory agencies that runoff meets State Water Quality Standards. Nevertheless, it is important monitor runoff to answer the following questions:

- What are the most cost-effective means of removing pollutants?
- How effectively do WSDOT's stormwater treatment facilities remove pollutants?
- How should WSDOT vary its treatment approaches for stormwater, given the highly variable nature of highways, climates and receiving streams?

Where and how does WSDOT sample stormwater?

WSDOT collects stormwater samples at the inlets and outlets of stormwater treatment facilities to determine how effectively they remove pollutants and how clean the water is after treatment. These facilities are referred to as Best Management Practices (BMPs). It is important to note that BMP is a broad term that in other instances includes management practices that prevent pollution from occurring in the first place. Tested BMPs were built to 1995 design standards.

Composite sampling produces average results compared to discrete grab samples, which are snapshots in time. Grab sampling, however, is the only way to collect samples for some pollutants like oil. Likewise, grab sampling is sometimes the only feasible means of collecting samples in locations with low or unreliable flows.

As the weather is often unpredictable, and stormwater quality varies throughout each storm, automated sampling devices are used in accordance with Federal Highway Administration guidance. The samplers are programmed to automatically collect samples in proportion to rainfall intensity or by the amount of water flowing through the BMP. The samples are combined to produce single "composite" samples that represent the average water quality during the storm. Following a storm, the samples are sent to a laboratory for analysis. Flow and rain data are also collected to characterize the rain event associated with each water quality sample.

An automated sampling device near a stormwater pond.

Which pollutants are of most concern to WSDOT and why?

Past data collected by WSDOT along with data collected by other state transportation agencies indicate that the pollutants listed in Exhibit 6-1 warrant the most attention in highway runoff. State water quality standards and/or BMP performance goals exist for these pollutants of concern which, set clear objectives for treatment effectiveness.

Note: Theft and vandalism of equipment makes it increasingly difficult to monitor stormwater using automated sampling devices. Despite escalating security measures, $10,000 worth of equipment was stolen or destroyed in the past three years.

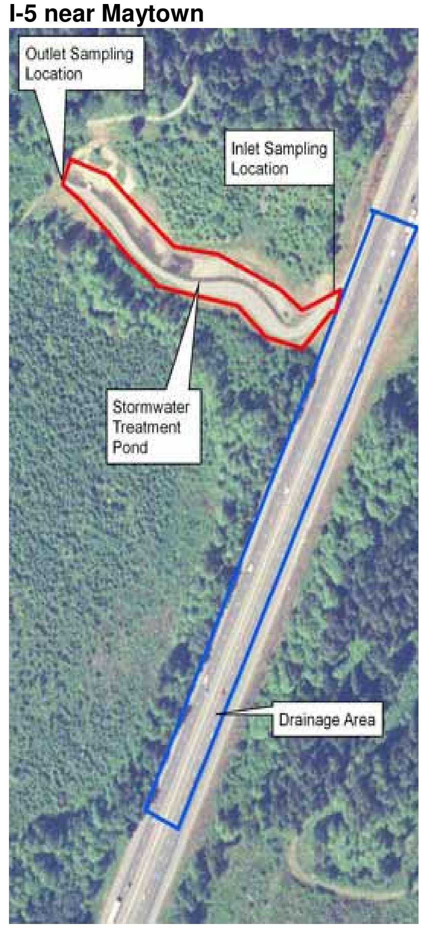
Exhibit 6-1
Pollutants of Concern

Pollutant	Priority	Reason for level of concern	Major sources
Total Suspended Solids	High	Total Suspended Solids is a measure of all the tiny bits of dirt and grime that are suspended in water. While not a regulated pollutant, such solids are a good indicator that other pollutants are present because many other pollutants attach to suspended solids. Accordingly, BMPs that reduce solids effectively reduce most other pollutants as well. The Department of Ecology has set an 80% removal efficiency of Total Suspended Solids as the performance goal for Basic Treatment.	Road wear, vehicles, deicing sands, erosion, and atmosphere (dust, leaves, and rotten bits of pine needles, etc.)
Copper	High	Fish are highly sensitive to dissolved copper and the State water quality standards are set at very low concentrations. Untreated, urban highway runoff frequently exceeds State standards and the effectiveness of required BMPs is variable. This is because the copper concentrations are very low and difficult to further reduce. To provide some perspective, the weight of dissolved copper that washes off of WSDOT's busiest highways before treatment is comparable to five pennies per acre each year.	Vehicle wear i.e. brakes, bearings, metal plating, engine parts
Zinc	High	There is more zinc in highway runoff than any other State-regulated metal. Untreated runoff from urban highways frequently exceeds State standards.	Tire wear, corrosion of zinc-covered metals.
Oil and grease	Low	State law doesn't allow the discharge of pollutants that alter the color, taste or odor of water, which small amounts oil and grease can easily do. Likewise, increasing concentrations of oil and grease may suggest an increased likelihood that other, more harmful oil-based substances are present. Oil and grease are a low priority for WSDOT highways because past sampling has shown that oil and grease concentrations are usually low and easily treated.	Vehicle lubricants
Phosphates	Low	Excessive phosphates can cause unwanted algae blooms in lakes. Phosphate concentrations in highway runoff are comparable to runoff from other land uses. Treatment facilities tested by WSDOT surpass the performance goals set by Ecology.	Atmospheric deposition (i.e. dust, pine needles, leaves), fertilizers, and eroded soils
Fecal coliform	Low	Fecal coliform indicates pollution from animal or human wastes that increase the potential for catching diseases.	Birds and other wildlife, pets, sewage leaks to storms drains, etc.

What were WSDOT's monitoring objectives for 2005-2006?

The focus of monitoring for this reporting period was to evaluate the effectiveness of BMPs at reducing concentrations of the pollutants described previously (Exhibit 6-1) on highways with high, moderate, and low traffic levels. Increased monitoring was performed to further characterize water quality along low traffic rural highways and to better understand the effect of different traffic levels on pollutant concentrations. Sampling was also continued in order to help determine the sources of fecal coliform bacteria in highway runoff, and the effectiveness of BMPs at removing fecal pollution.

Example of a monitoring location: I-5 near Maytown



What sites were selected for treatment facility effectiveness monitoring in 2005-2006 and why?

Monitoring sites were selected to test the spectrum of treatment facility types ranging from vegetated shoulders and ditches to ponds and vaults constructed in accordance with the design criteria in WSDOT's 1995 *Highway Runoff Manual*. As in the previous reporting period, sampling locations were selected along high, moderate, and low traffic roadways having average daily traffic (ADT) ranging from approximately 16,000 to 180,000 vehicles. BMPs were monitored along high-traffic Interstate highways first to determine the quality of treated runoff in areas where pollutant loads are thought to be the highest. During this reporting period additional monitoring was initiated along moderate and low traffic state highways to determine the effectiveness of BMPs along WSDOT's more numerous local highways. Fecal coliform testing sites were also added in the winter of 2005 and spring of 2006.

Criteria for selecting sampling sites included: 1) well defined drainage area that did not receive water from adjacent properties, 2) accessibility and security for maintaining sampling equipment, 3) safety, and 4) proximity to offices with sampling staff and equipment. The newly selected sampling locations were located within Snohomish County (Island-Snohomish permit area), King County, and Clark County. Whenever feasible, automated samplers were installed at the inlets and outlets of stormwater treatment BMPs. In cases where safety considerations prohibited sampling at the facility inlet, nearby reference sites were selected to represent untreated runoff. Monitoring site descriptions follow in Appendix 6-A. Exact locations are not provided for security reasons.

How does WSDOT ensure quality control?

WSDOT prepared a quality control plan called a Quality Assurance Project Plan (QAPP) (Tetra Tech 2003). QAPPs are required by the Department of Ecology to ensure that collected data meets quality standards so these data sets can be compared to data collected elsewhere. An addendum to the QAPP was prepared in 2004 and 2005 (Tetra Tech, Inc. 2004) (Herrera Environmental Consultants, Inc. 2005) to address added sampling locations along low to moderate-traffic highways and fecal coliform bacteria sampling. The QAPPs are on file with the WSDOT's Water Quality Program. Samples collected from the referenced sites were analyzed for total suspended solids (TSS), hardness (see sidebar), total phosphorous, and for the dissolved and total forms of copper and zinc. In accordance with the referenced monitoring plan, grab samples were collected and analyzed for the presence of total petroleum

Hardness is a measure of how much calcium and magnesium is present in water. Hardness is not a regulated parameter but it is needed to determine the water quality standards for metals like copper and zinc. Toxicity of metals decreases with increasing water hardness.

BMP (Best Management Practice) is actually a broader term that refers to both pollution prevention and pollution treatment. In this case BMP refers to facilities that remove pollutants from water.

hydrocarbons (TPH) when sheens were observed in the stormwater runoff at sampling sites. Grab samples were also collected and analyzed to determine fecal coliform bacteria concentrations.

How does one measure BMP effectiveness?

Paired sampling is required to measure BMP effectiveness. Paired sampling means that BMP inflow and outflow samples are collected during a storm for comparison. This is necessary to measure how effective different BMP treatments are at reducing pollutant concentrations.

Where feasible, total volumes of water both entering and leaving a BMP are also compared to determine what amount of pollutants is trapped when water evaporates or soaks into the ground. In cases where large water volume reductions are achieved, in addition to pollutant concentration reductions, the total amount or load of pollutants that are discharged is greatly reduced. It is much more difficult logistically to quantify load reductions because more data is required. However, load reduction is a more useful measure of how effectively a BMP reduces the amount of pollutants reaching a receiving waterbody.

What do the results tell us?

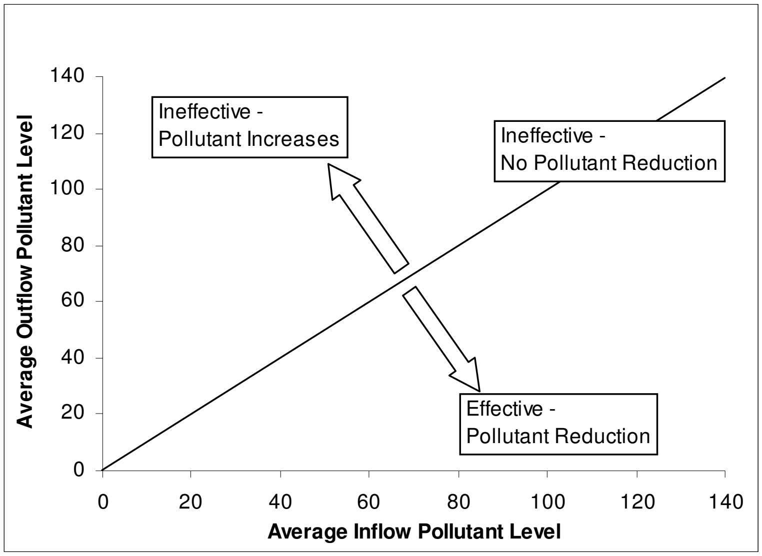
Data from several years of monitoring has been combined to show all BMP effectiveness data collected from 2003 through 2006. The data has been summarized in graphs so readers can quickly compare the quality of treated water to applicable water quality standards, and can view the effectiveness of different BMPs in relation to each other. The data are also presented in tabular form in Appendix 6-B. The original lab reports are several hundred pages thick, so they are kept on file at WSDOT and not included in this report.

How is the data displayed and how do I read the graphs?

Exhibit 6-2 shows how to interpret the graphs, which follow. Each point on a graph represents stormwater pollution levels entering and leaving a BMP during a storm-event. The horizontal position of each point indicates how polluted the water was before it was treated. The vertical position indicates the corresponding pollution level after the water was treated. For untreated (pre-BMP) water, the farther to the left a point is on the graph, the lower the pollutant level; the farther to the right, the higher the pollutant level. For the corresponding post-treatment pollution level, the closer the point is to the bottom of the graph the cleaner the water; the closer to the top, the higher the pollutant level.

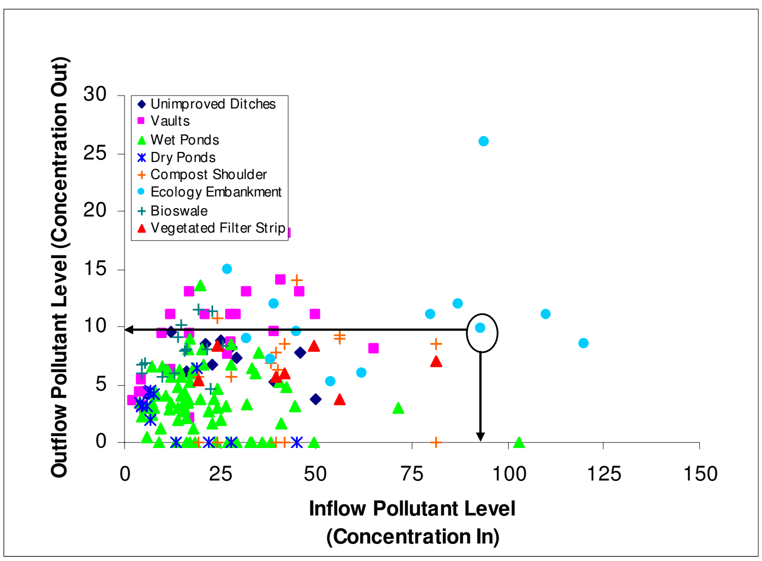
Two graphs are presented for each pollutant. Each point on the first graph (top) represents the average of all data collected per BMP. The second graph shows paired (not averaged) data for the same pollutant to demonstrate variability. Each point on the second graph represents one paired sample.

Exhibit 6-2
Average Pollutant Concentration Reduction



These graphs show the overall effectiveness of different BMPs. For each BMP type, data from all storms are averaged for each facility. Horizontal and vertical (x and y) axes are similar scales. There is a diagonal line, which represents no effect. Points, which fall along this line, indicate pollutant concentration did not change as water passed through the treatment facility. Points above the diagonal line indicate that more pollutant left the facility than entered it (pollution increased). Points below the diagonal line indicate pollutant decrease.

Pollutant Concentration Reduction Per Storm



These paired-sample graphs illustrate treatment effectiveness of the different BMPs. Each point represents average treatment for one BMP during one storm. The horizontal and vertical (x and y) axes on these graphs are different scales to visually spread out all data points from all storms. Data for this example are for total copper, and units are micrograms per liter (*u*g/L). Note that the horizontal axis (concentration of pollutant before entering the BMP) goes from zero to 150 and the vertical axis (post-treatment concentration) goes from zero to 30, indicating that treated water is much cleaner than untreated water. For the circled point, water going in at 93 *u*g/L came out at 9.8 *u*g/L.

Total Suspended Solids (TSS): Exhibit 6-3 shows the average TSS entering and exiting each type of monitored BMP. The overall average concentration of TSS flowing into the treatment facilities is 120 mg/L and the average concentration of TSS flowing out of the treatment facilities is 8 mg/L. All BMPs are highly effective, removing a combined average 93% of TSS, which exceeds the performance goal of 80% removal set by the Department of Ecology. As mentioned in Exhibit 6-1, when TSS is removed from the water many other pollutants that are attached to the sediment are removed as well.

Exhibit 6-3

Average TSS Concentration Reduction Removal by BMP

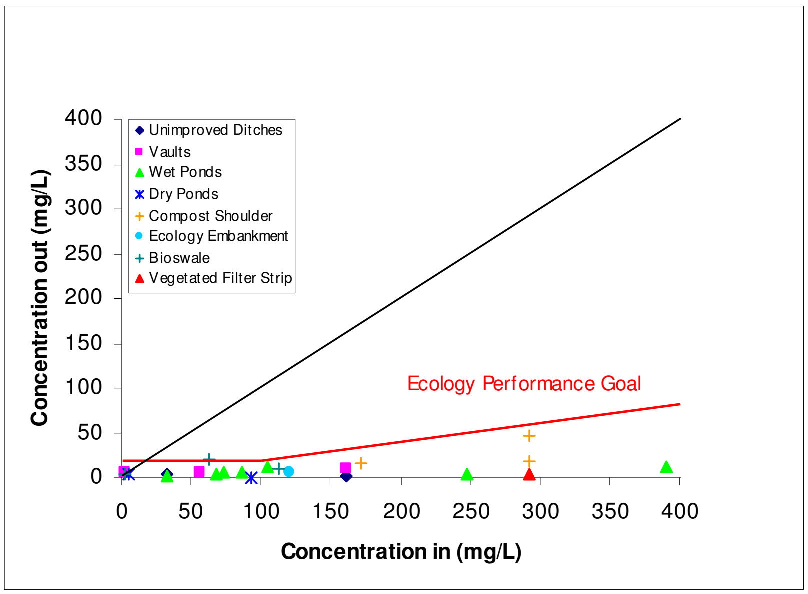
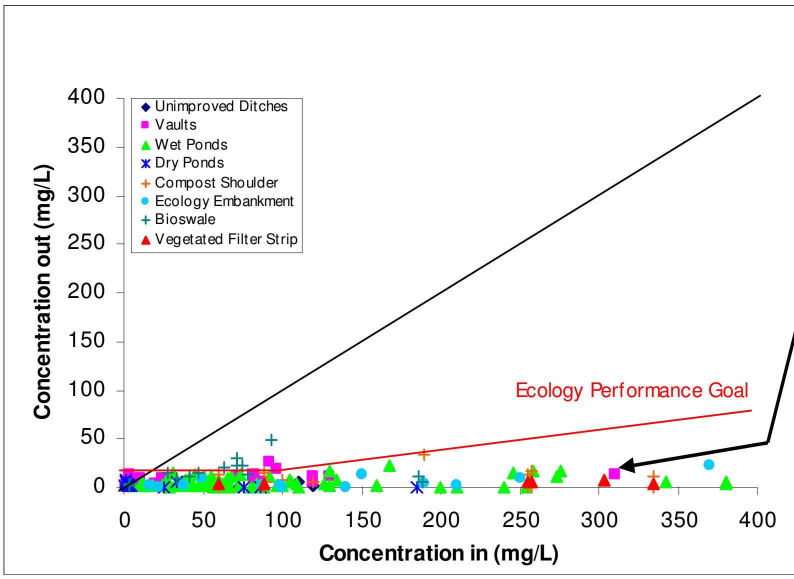


Exhibit 6-3 shows that all tested BMPs were effective at removing TSS. Very little TSS came out of any of the BMPs no matter how much went into them. For example, the average concentration of TSS entering the ecology embankment was 121 mg/L and the average concentration going out of the Ecology Embankment was 6 mg/L. Data points below the line representing the Department of Ecology's performance goal indicate that BMPs perform better than the goal.

It is important to note that even though TSS is the easiest pollutant to remove on a consistent basis, the quality of treated water is still variable. All tested BMPs exceeded performance standards for TSS on average, yet performance was highly variable on a storm-by storm basis within a single BMP as well as among and between BMPs types. The variability is a result of many interacting factors including weather, drainage basin configuration, inflow concentration, etc. This variability makes it very difficult to guarantee compliance with standards during all storms or conclusively demonstrate one BMP type is better than another. To illustrate the variable nature of stormwater paired-sampling, event data for TSS is shown in Exhibit 6-4.

Exhibit 6-4
Average TSS Removal Per storm



A single point represents each storm when paired data are plotted. The indicated point in Exhibit 6-4 graph represents a storm in which the TSS concentration was 310 mg/L going into a vault and 13 mg/L going out. The vault removed 96% of TSS during that storm.

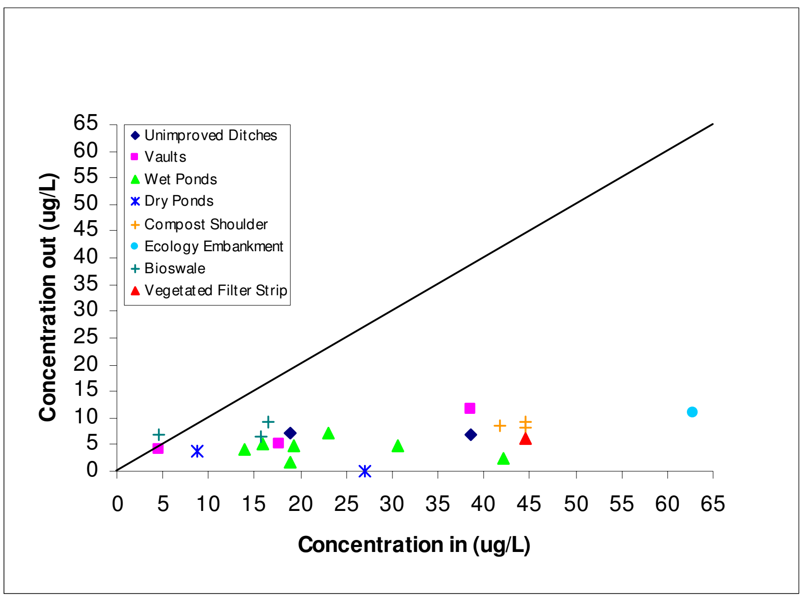
The variability in Exhibit 6-4 is typical of stormwater. This variability makes it impossible to claim than any BMP can successfully clean the water all of the time. The variability also makes it difficult to compare BMP effectiveness.

Total Copper: Exhibit 6-5 shows that all BMP types effectively reduce copper concentrations and removal efficiency increases with increasing incoming copper concentrations. Tested BMPs removed larger fractions of total copper when incoming copper concentrations were high. Total copper consists of the copper particles that can settle out of the water and dissolved copper, which does not settle out of the water. Most of the copper that is removed as part of "total copper" is in the form of particles. Particles of metals are not toxic to aquatic life but excessive dissolved metals are. Exhibit 6-6 shows that concentrations of total copper in treated runoff are variable but much lower than in untreated runoff.

Removal efficiency rates are not always a good means of gauging BMP effectiveness. It is easier to remove most of the pollutants when water entering a BMP is really dirty. It is very difficult to remove even a small amount of pollutants when the water entering a BMP is fairly clean.

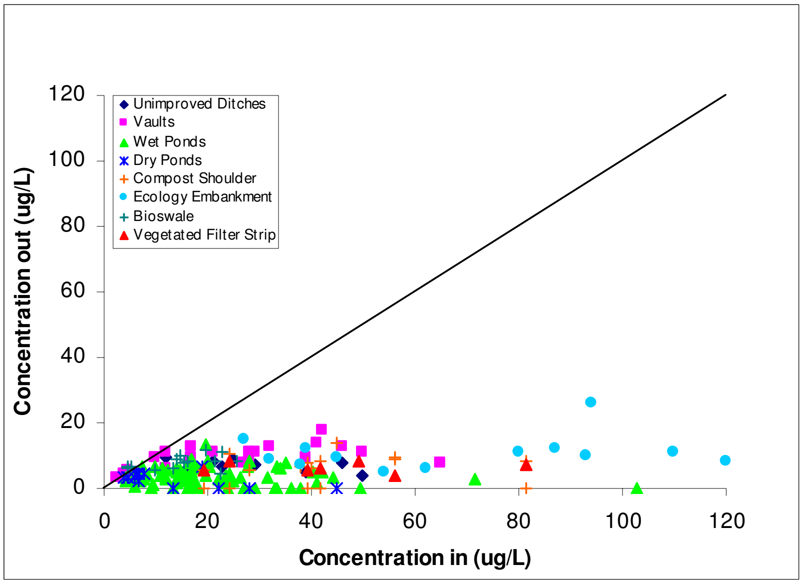
Exhibit 6-5

Overall Average Total Copper Removal by BMP



Total copper data reveals how variable the quality of untreated runoff is from place to place. A pollutant removal efficiency increases with increasing incoming concentration, however, copper concentrations in treated water were less variable.

Exhibit 6-6
Total Copper Removal per Storm



The numerous data points showing that no copper was discharged from wet ponds and dry ponds represent storms in which no water flowed through the pond outlets. All water was stored in the ponds and later evaporated or soaked into the ground.

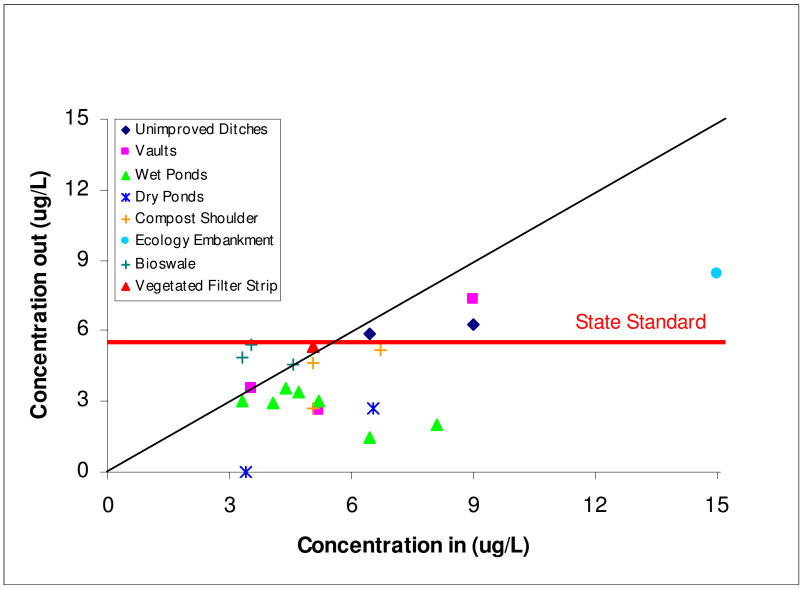
Dissolved copper: It is much harder to remove dissolved copper particles than solid copper particles because dissolved copper must chemically bind to something before it can settle out of the water. Removing minute quantities of dissolved metal when the water chemistry constantly changes throughout and between storms is a big challenge. As no highly effective or reliable methods for removing dissolved metals have been identified at this time, the Department of Ecology has not established any numeric performance goals for the removal of dissolved metals.

Surface water standards for copper are 325 times more stringent than drinking water standards. Laboratory studies suggest that small concentrations of dissolved copper can cause nerve damage in fish.

Exhibit 6-7 shows that available BMPs remove, on average, between one quarter and one third of the dissolved copper. Exhibit 6-8 shows that treated stormwater meets dissolved copper standards for typical receiving waters about 76% of the time.

Exhibit 6-7

Overall Average Dissolved Copper Removal by BMP



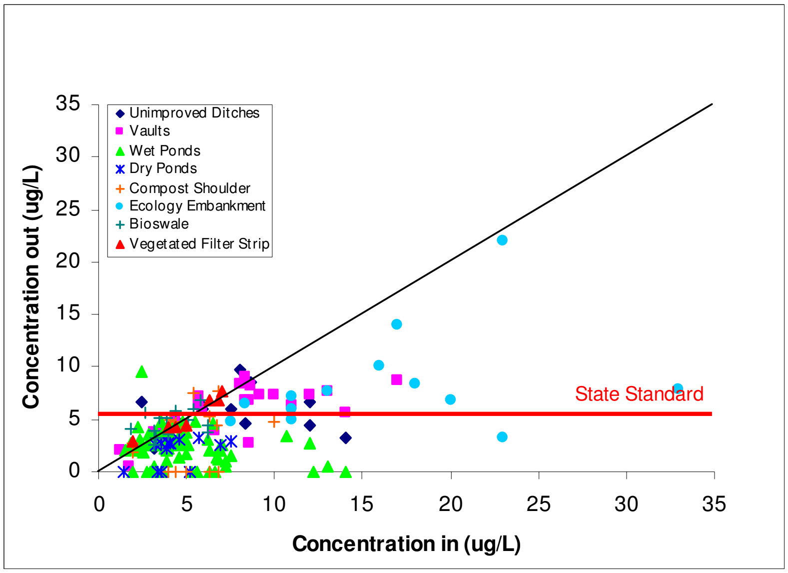
*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentration and in-stream water chemistry determine compliance in the receiving stream.

To provide some perspective, the weight of dissolved copper that washes off of the WSDOT-monitored sites before treatment is comparable to the weight of 5 pennies per acre each year.

Wet and dry ponds appear to produce runoff with the lowest dissolved copper concentrations. The better performance of wet and dry ponds is partially due to several storm events in which no water left the ponds. All water was stored and later soaked into the ground or evaporated.

The paired sample data in Exhibit 6-8 indicates that BMP effectiveness in removing dissolved copper varies greatly between storms. When data are so variable it is difficult to claim that perceived differences are significant. It is also difficult to compare BMP effectiveness when the concentration of pollutants entering them is so variable.

Exhibit 6-8
Dissolved Copper Removal Per Storm



*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentrations and in-stream water chemistry determine compliance in the receiving stream.

Total Zinc: Exhibits 6-9 and 6-10 indicate that all of the tested BMPs did a good job of reducing total zinc concentrations when incoming concentrations were high. Total zinc consists of the particles that can settle out of the water and dissolved zinc, which does not settle out of the water. Most of the zinc that is removed as part of "total zinc" is in the form of settleable particles.

Exhibit 6-9
Overall Average Total Zinc Removal by BMP

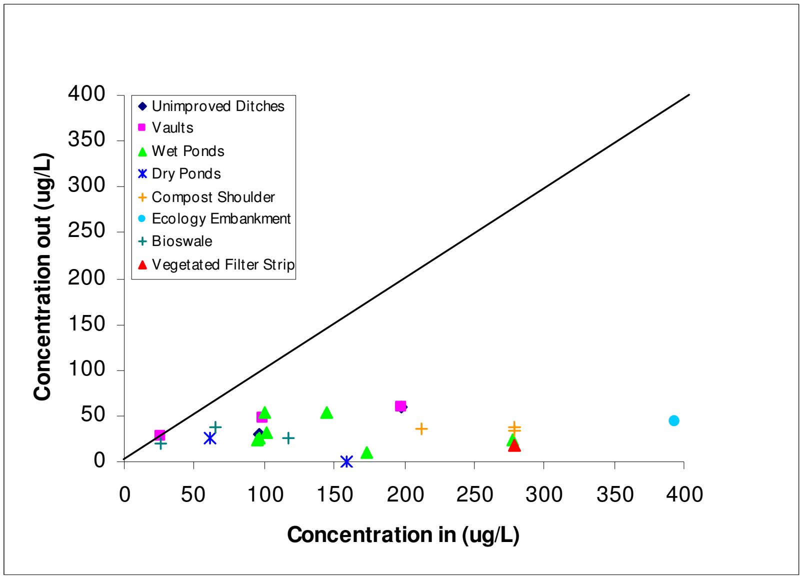
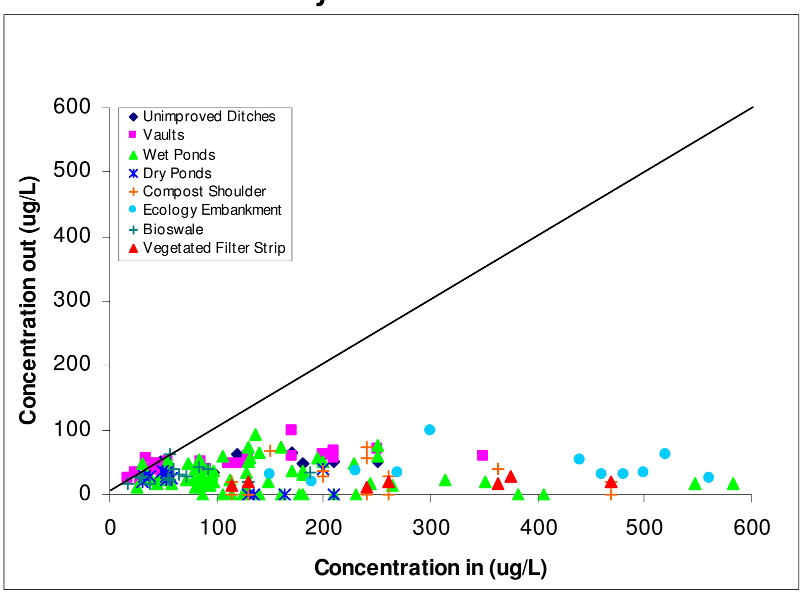


Exhibit 6-10
Total Zinc Removal by BMP Per Storm

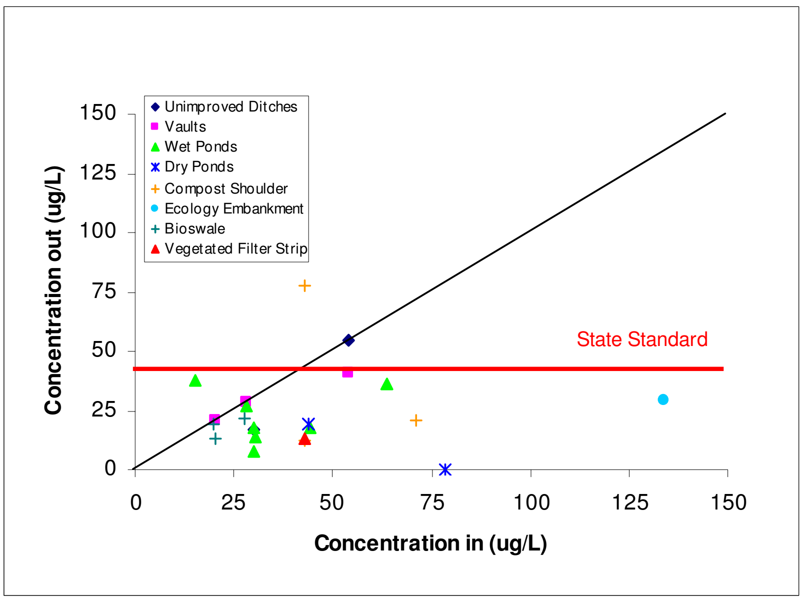


Exhibits 6-9 and 6-10 illustrate the potential problem of judging BMP effectiveness based on percent removal efficiency. The BMPs remove most of the zinc when incoming concentrations are high but can't remove zinc when incoming concentrations are low. They also illustrate the variability of untreated runoff.

Dissolved Zinc: Exhibit 6-11 shows that tested BMPs were more effective at removing dissolved zinc than they were at removing dissolved copper. The same challenges exist with removing dissolved zinc as those that exist for dissolved copper. However, dissolved zinc more readily binds to particles than does dissolved copper. Exhibit 6-12 shows that treated water at the tested sites, met the typical receiving water state standards for dissolved zinc during about 85% of sampled storms.

Exhibit 6-11

Overall Average Dissolved Zinc Removal by BMP

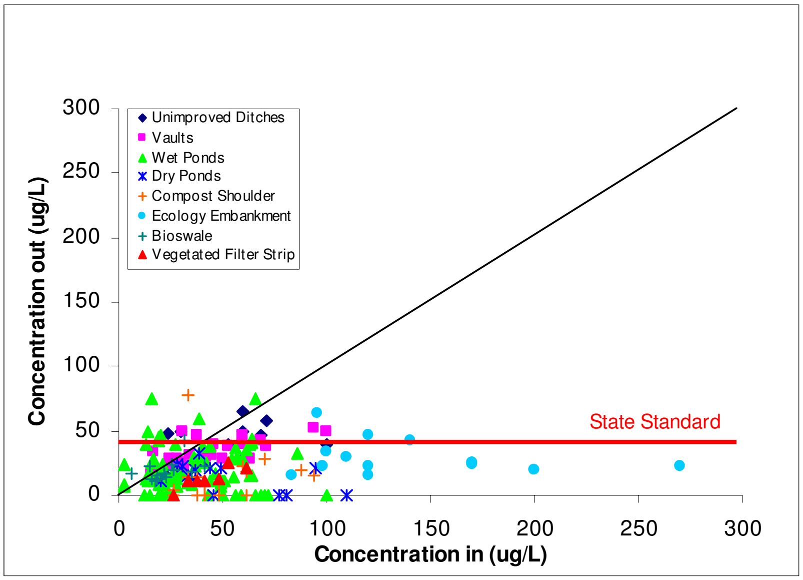


*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentrations and in-stream water chemistry determine compliance in the receiving stream.

WSDOT data indicates that the concentrations of dissolved zinc are not closely linked to traffic levels. The traffic levels at the bioswale and ecology embankment sites are similar yet inflowing pollutant concentrations vary dramatically.

Exhibit 6-12 shows paired data indicating that BMP effectiveness varies greatly between storms. The exhibit also shows that the ecology embankment effectively removes dissolved zinc even when zinc enters it at unusually high concentrations.

Exhibit 6-12
Dissolved Zinc Removal Per Storm



*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentrations and in-stream water chemistry determine compliance in the receiving stream.

Oil Control: Stormwater is sampled for oil whenever oily sheens are observed. There is no numeric state water quality standard for oil but state water quality standards don't allow anything to adversely affect the aesthetics, smell or taste of water. To protect water from oily runoff the Department of Ecology has recently established triggers for requiring oil control treatment BMPs. The performance goal for oil control BMPs is "no ongoing or recurring visible sheen, and to have a 24- hour average Total Petroleum Hydrocarbon concentration no greater than 10 mg/L, and a maximum of 15 mg/L for a

As past sampling data indicate that numeric performance goals are consistently met when there is no visible sheen, WSDOT uses oil sheens as the trigger to perform oil control monitoring.

discrete sample (Washington State Department of Ecology 2001)." The oil control options in the Ecology Stormwater manuals include oil/water separators, sand filters and catch basin inserts.

The new highway-relevant trigger for constructing oil control treatment BMPs is traffic exceeding 25,000 cars crossing 15,000 cars at lighted intersections (like Aurora Ave. in north Seattle and Division St. in downtown Spokane). As oil-control BMPs have not yet been built at any such intersections, testing of BMPs at such locations isn't possible.

WSDOT monitored for oil and grease at all test sites during this monitoring period whenever sheens were observed. Oil sheens were observed on water entering the BMPs during 32 of 94 monitored storms. The average oil concentration in untreated water was 2.83 mg/L, which is considerably lower than the numeric performance goal for treated water. Only one incoming sheen contained more oil (17.13 mg/L) than the performance goal for treated water.

All stormwater leaving the tested BMPs met both the narrative standard of no visible sheen and the numeric performance goals. The average oil concentration in treated water was 0.39 mg/L which is 25 times cleaner than the 24- hour average total petroleum hydrocarbon concentration performance goal associated with oil treatment BMPs. This year's data reinforces observations made in the 2004 and 2005 reports that, in the general highway setting, basic treatment BMPs meet performance goals associated with oil control BMPs in Ecology's stormwater management manuals (Ecology 2001).

Total Phosphorus: Small concentrations of phosphorus are present in runoff that can contribute to undesirable algae blooms in lakes. To protect lakes from algae blooms, Department of Ecology has established a special treatment facility menu for removing phosphorus in their stormwater

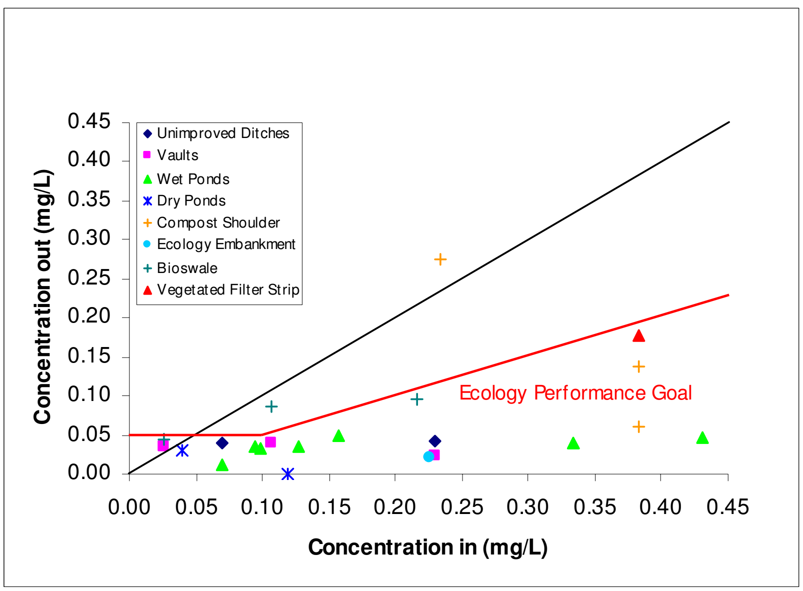
Most of the phosphorus in stormwater is attached to suspended particles. Because WSDOT's BMPs are highly effective at removing particles (TSS), they are also effective at removing total phosphorus.

treatment manuals. The treatment menu includes sand filters or combinations of BMPs. The performance goal for this special set of treatment options is 50% removal when the incoming concentration is between 0.1 and 0.5 mg/L.

The tested BMPs, except for the compost shoulder and ecology embankment (see sidebar), are all considered "basic treatment" BMPs and are not recognized in Ecology's stormwater manuals as adequate for meeting the total phosphorus removal performance goal. However, Exhibit 6-13 shows that these BMPs effectively remove phosphorus from runoff. Exhibit 6-14 shows the phosphorus removal efficiency per storm of the tested "basic treatment" BMPs averaged 73% which is far better than the performance goal that Department of Ecology has established for the special, more expensive phosphorus treatment menu options.

One of the monitored compost shoulders slightly increased the concentration of phosphorus in runoff. The compost acted as a sponge however, allowing 2/3 of the stormwater to infiltrate. When infiltration is considered at that site, phosphorus was reduced by 54%.

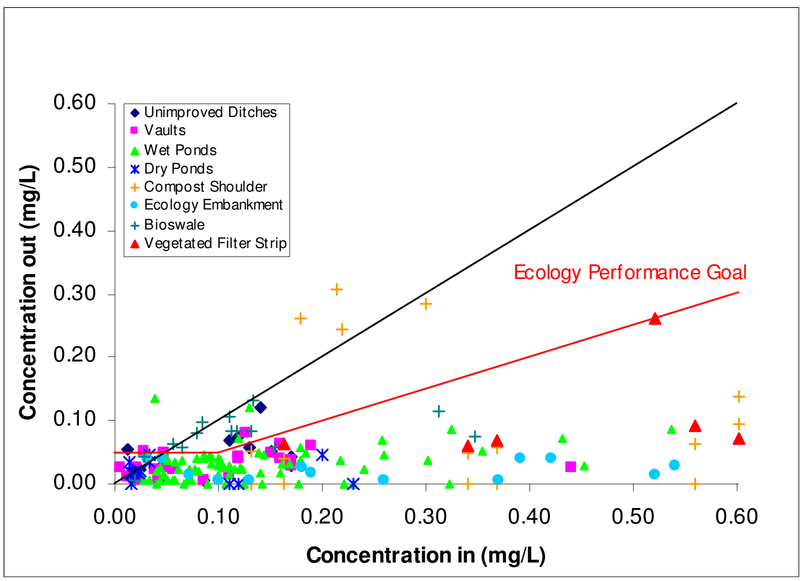
Exhibit 6-13
Overall Average Total Phosphorus Removal by BMP



The paired data in Exhibit 6-14 shows that nearly all treated water samples leaving all of the BMPs contained about the same concentration of phosphorus regardless of the concentration of phosphorus coming into them. The data shows that there is an "irreducible minimum concentration" meaning a bottom concentration below which none of the BMPs can reliably remove phosphorus. An irreducible minimum concentration should be expected for phosphorus, as it is a nutrient that naturally cycles through the environment and can never be completely eliminated.

Exhibit 6-14

Total Phosphorus Removed Per Storm



Ecology's performance goal for Total Phosphorus is based on the percent removal of pollutants by the BMPs. As the concentration of phosphorus entering a BMP increases, the target concentration for discharges increases accordingly.

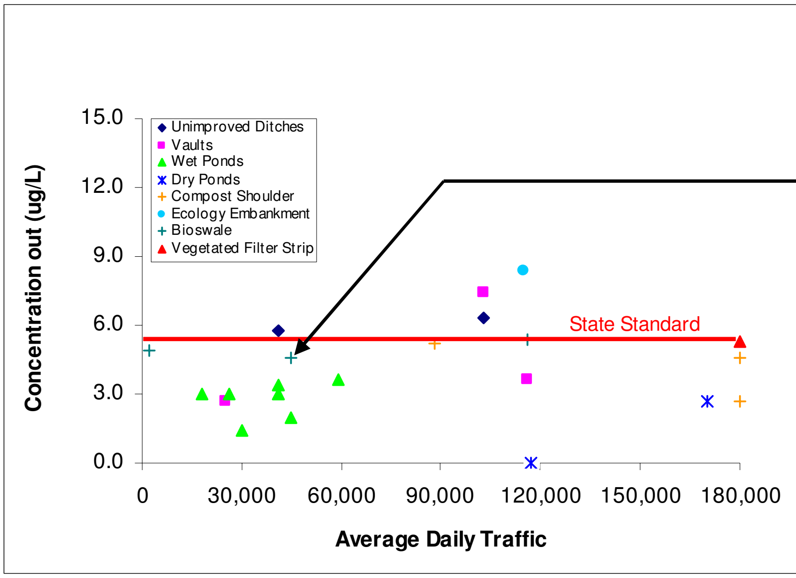
How does traffic level affect water quality?

As cars are a source of pollutants, one would expect highway runoff pollutant concentrations to increase with increasing traffic. This expectation is so logical that many people believe that highway runoff pollutants increase in tandem with increasing traffic. The belief is reflected in recent stormwater requirements that include triggers for "Enhanced" dissolved metals treatment based on the average number of vehicles that travel a highway each day measured as Average Daily Trips (ADT). The thresholds are based on the premise that once the ADT rises to a certain level, the metals concentrations are so high that basic treatment BMPs will not be able to effectively remove them. Unfortunately, inadequate data had been collected to verify whether or not dissolved metals concentrations in treated highway runoff could be correlated with ADT on Washington's highways. WSDOT now has enough data to start evaluating the effects of ADT on treated runoff pollutant concentrations with the data collected during this reporting period.

Ecology's stormwater management manuals require "Enhanced" metals treatment BMPs when traffic levels exceed 7,500, 15,000 or 30,000 ADT depending on Urban Growth Area designations and other factors.

Exhibits 6-15 though 6-18 compare concentrations of copper and zinc in treated highway runoff across a broad range of ADTs. No meaningful relationships between ADT and treated runoff pollutant concentrations were observed. Data collected so far suggests that ADT is not a reliable predictor of pollutant concentrations and is not a useful tool for establishing treatment triggers. Unfortunately, no other single variable can be identified as a reliable predictor of pollutant concentrations based on WSDOT data at this point. So many variables interact to affect pollutant concentrations that it may be impossible to set meaningful thresholds based on a single variable like ADT. However, WSDOT continues to search for scientifically defensible treatment triggers so the most appropriate BMPs will be built where they will do the most good.

Exhibit 6-15
Average Dissolved Copper Concentrations In Treated Runoff vs. ADT



A single point represents the average outflowing amount of pollutants for a single BMP compared with the ADT for that Highway location. The indicated data point represents a bioswale in which the average dissolved copper concentration in treated water was 4.6 ug/L at a highway location with an ADT of 45,000.

Exhibit 6-16
Average Total Copper Concentrations In Treated Runoff vs. ADT

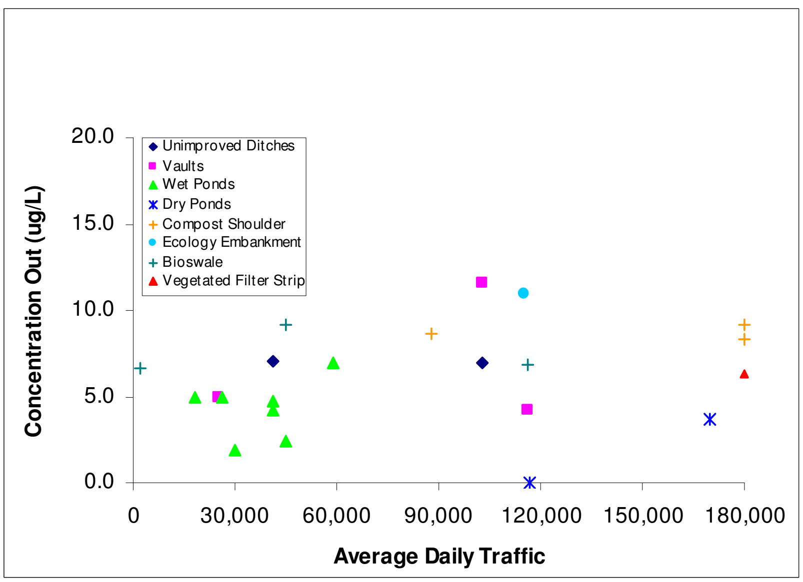


Exhibit 6-17
Average Dissolved Zinc Concentrations In Treated Runoff vs. ADT

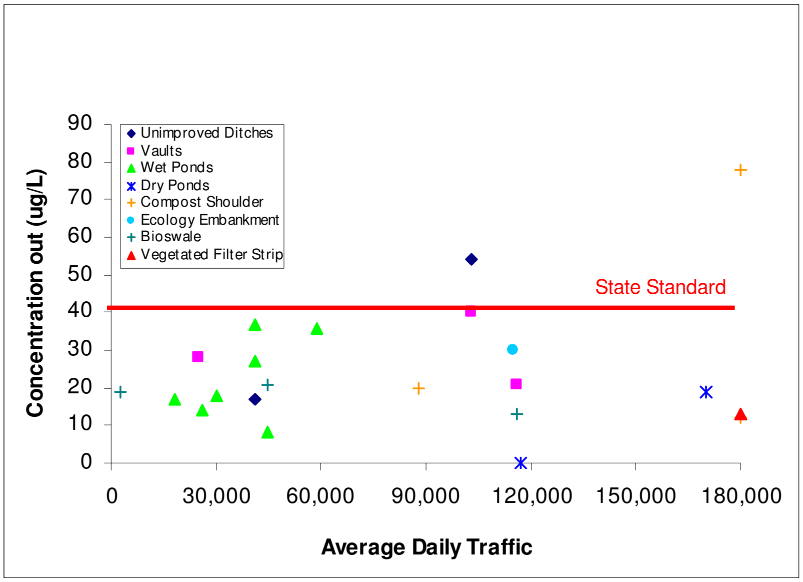
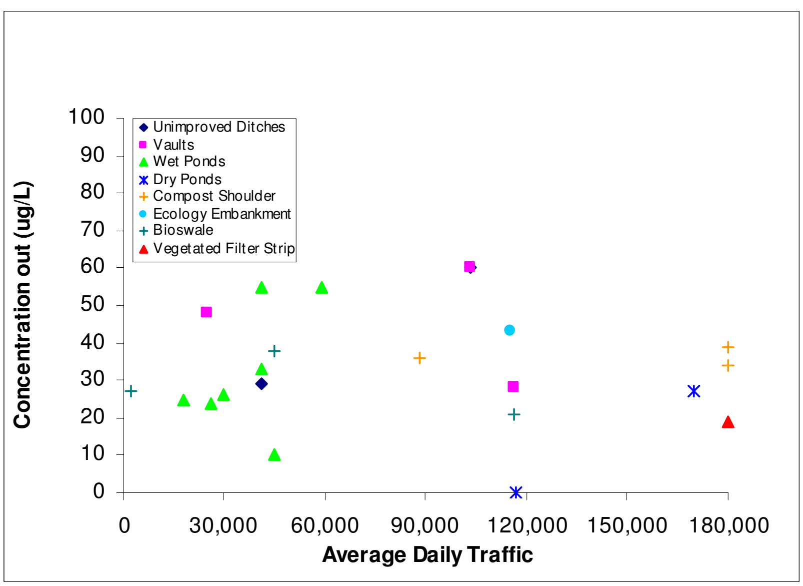


Exhibit 6-18
Average Total Zinc Concentration In Treated Runoff vs. ADT



How well do WSDOT BMPs reduce pollutant loads?

Pollutant “load” is the amount of pollution that enters a receiving waterbody over time. Pollutant load is important because it quantifies the amount of pollution escaping into the environment. Pollutant load is calculated by multiplying the concentration of pollutants in the water by the volume of water discharged over time. This method of evaluating treatment effectiveness is far more challenging to than quantifying pollutant concentrations alone because it is difficult to account for all sources of inflowing and outflowing water. This is because water soaks into the ground on some days, seeps out of the ground on other days, and measuring such flows is very difficult.

When large amounts of water soak into the ground, pollutant load reductions can be considerably larger than one might think when looking solely at concentration reduction data. As large amounts of water infiltrate in most BMPs, WSDOT’s treatment facilities usually remove more pollutants than we can quantify using concentration reduction data alone. During this reporting period, pollutant load reductions were quantified for two BMPs (Exhibits 6-19 and 6-20) and load reductions were shown to be higher than concentration reductions. Measuring load reductions due to infiltration is especially important when it comes to pollutants like dissolved copper because the BMPs have difficulty reducing their concentrations. With pollutants like dissolved copper, load reduction data more accurately represents the benefits of treatment BMPs.

Exhibit 6-19
Concentration And Load Reductions For A Vegetated Filter Strip Along Interstate 5

Pollutant	Concentration % Reduction	Load % Reduction
TP	82	91
TSS	98	99
Total Cu	86	94
Dis. Cu	0.4	48
Total Zn	94	97
Dis. Zn	71	86

Exhibit 6-20
Concentration And Load Reductions For A Compost Shoulder Along Interstate 5

Pollutant	Concentration % Reduction	Load % Reduction
TP	84	96
TSS	94	98
Total Cu	81	96
Dis. Cu	8	78
Total Zn	86	98
Dis. Zn	73	93

It is important to note that annual load reductions are probably higher than we were able to document in Exhibits 6-19 and 6-20 because they are based solely on monitoring of wet-season storms that had water leaving the BMPs. Quantifying load reductions in the dry-season is more difficult because flows are too low to measure. It is suspected that dry-season runoff contains higher pollutant concentrations. However, most storms between April and October completely infiltrate in the majority of BMPs and this runoff is often not measurable.

Subsequently, this additional source of load reduction is not captured in our BMP effectiveness monitoring.

Why is WSDOT monitoring fecal coliform bacteria in stormwater?

Fecal Coliform Bacteria: The Department of Ecology is preparing clean up plans to reduce the amount of fecal coliform bacteria (fecal coliform) in polluted waterways. These plans are supposed to identify and quantify the sources of fecal coliform in waterbodies that exceed state standards on a regular basis. The most stringent state standard is for Class AA freshwaters:

Fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL and not have more than 10% of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL (WAC 173-201A-030).

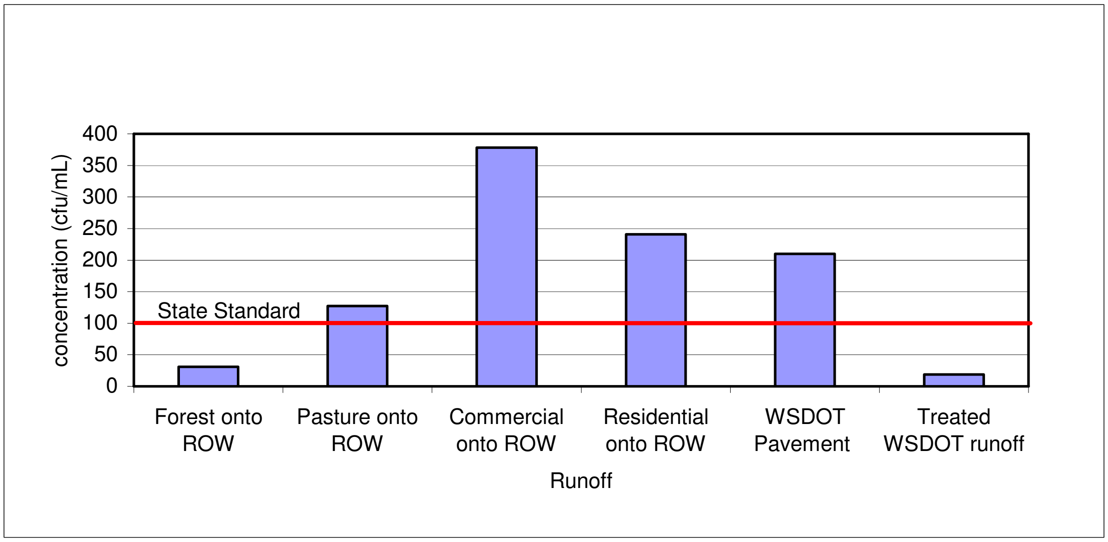
Once the sources of fecal coliform are identified, management strategies and goals are set to eliminate or reduce the problem sources. While highways and cars don't produce fecal matter, concern has been expressed that fecal matter flows into and through highway stormwater systems before entering our State's waterways. In response to these concerns, WSDOT initiated a limited fecal coliform sampling program in 2004. The purpose of this monitoring effort in 2004-2005 was to get some preliminary data regarding how much fecal coliform is present in: 1) water flowing onto highway rights-of-way from adjacent properties, 2) untreated highway runoff, and 3) treated runoff. Data is summarized in Exhibit 6-21 to put the 2004-2005 data in context.

Fecal coliform is measured in colony forming units (cfu). Cfu's are measured by putting a water sample in a petri dish and later counting the number colonies of bacteria that grow on the gel.

Geometric means are often useful summaries for highly variable data such as fecal coliform measurements. The geometric mean is a measure of central tendency and dampens the effects of rare, extremely large measurements in a data set. The geometric mean of a data set is always smaller than or equal to the set's traditional mean (average).

Exhibit 6-21

Fecal Coliform Concentrations In Untreated Water Entering WSDOT's Right-Of-Way, Untreated Water Leaving WSDOT Pavement, and Treated Highway Runoff



More data was collected in this reporting period to get a better understanding of how effective our BMPs are at removing fecal coliform from highway runoff. A total of 28 paired runoff samples were collected at the inlets and outlets of seven BMPs including five wet ponds and two bioswales. On average, the treated water samples contained far less fecal coliform (Geometric mean of 40 cfu/mL) than untreated highway runoff (307 cfu/ml). The data suggests that monitored ponds and bioswales removed, on average, 87% of the fecal coliform and that treated water usually met the most stringent state standard for receiving waters. As fecal coliform is among the most variable of stormwater pollutants, data presented in this section is not conclusive. Sample locations are described in Appendix 6-A and BMP grab sampling data is presented in tabular form in Appendix 6-C.

How does fecal coliform get into highway runoff?

Studies from around the country indicate that birds are a major, sometimes dominant source of fecal coliform. Other potential sources include pets, wildlife and sewage leaks. Birds, pets and other wildlife are suspected to be the dominant sources of fecal coliform in the collected samples.

What can WSDOT do to reduce the amount of fecal coliform entering highway rights-of-way and stormwater?

If WSDOT observes that water entering the right-of-way is contaminated with sewage or animal wastes, WSDOT will notify the responsible landowner and the Department of Ecology so the problem can be corrected. WSDOT has no direct control over birds, other wildlife, or pets. Pet owners can eliminate pets as a source by responsibly disposing of wastes. In some cases WSDOT can reduce the amount of bird waste entering stormwater by designing bridges, signs, and light posts in a way that doesn't attract roosting birds. Likewise, the vegetation next to stormwater ponds can be managed to discourage pond use by waterfowl.

What is the runoff water quality along low traffic, rural highways?

As the Department of Ecology is expanding the requirements to provide enhanced metals treatment to low traffic, rural highways, it is important that WSDOT collect water quality data for such highways. Flow-weighted composite sampling is not feasible for most rural highways because runoff usually sheet flows off of the highway. This sheet flow only sporadically trickles down ditches and is in such low quantities that automated sampling devices can't be used. Other sampling approaches include "grab" sampling where a person simply fills a bottle of water. In cases where the water is not deep enough to fill a bottle, "overland flow" samplers can be used to sample the water (Federal Highway Administration 2001). Overland flow samplers consist of a bottle with ball valves that gradually fill up during storms. The samplers are installed flush with the ground surface so that sheet flows can trickle into them.

In the 2005 report WSDOT reported grab sample results collected along Highway 121, which is a rural highway with about 5,000 ADT in Thurston County. Highway 121 grab samples suggest that rural highway runoff water quality is very similar to runoff from undeveloped forests. Highway 121 data also suggests that, in at least this case, rural highway runoff is so clean that 1) water quality treatment BMPs might not be necessary to ensure compliance with water quality standards and that 2) BMPs would not make any water quality difference. Caution should be used, however, when interpreting data from limited sets of grab samples. WSDOT began collecting data using overland flow samplers to monitor rural highway runoff during this reporting period. If enough data can be collected using this method, WSDOT will begin reporting results in the 2007 Stormwater Report.

What does WSDOT's stormwater research program do?

Stormwater management is a complex task that involves numerous technical disciplines including hydraulics, hydrology, geology, soil and water chemistry, and water quality regulations. The relatively long and narrow nature of the highway road system limits the use of conventional stormwater management approaches. To help meet these challenges, WSDOT is focusing research efforts on methods that attempt to duplicate natural dispersion and infiltration. To this end, WSDOT's stormwater research strategy is a framework to:

- **Coordinate and build partnerships** within WSDOT and at regional, state, and federal levels to leverage stormwater research resources.
- **Provide a clear process** for soliciting, submitting, prioritizing, and implementing stormwater-related research proposals.
- **Find solutions** that improve stormwater management operations including.
    - pollutant removal
    - hydraulic performance
    - constructability
    - maintainability
    - maintenance practices
    - cost effectiveness
- **Improve the compilation, tracking, and dissemination** of stormwater research findings.

WSDOT's current highest priority research questions are:

- How can existing stormwater treatment system designs be modified to improve their infiltration capacities?
- What are the flow reduction and pollutant removal properties of:
    - Compost blankets on highway fill slopes?
    - WSDOT’s Roadside Manual’s vegetation restoration methods?

- What are the effects of slope length, angle, and impervious contributory area on natural dispersion applications? Is the existing design guidance appropriate?

An estimated $200,000 was spent on stormwater research during the current reporting period. Some projects span several reporting years. Specific projects recently completed or underway are:

- Completion of data compilation, analysis, and reporting for the Ecology Embankment linear roadside BMP; for approval by Ecology for general use (Herrera Environmental Consultants, Inc. 2006).
- Monitoring compost-amended vegetated filter strips (CAVFS) for flow control, to help WSDOT and Ecology calibrate models for estimating how much water is detained or infiltrated. Also evaluating pollutant-removal performance characteristics, compared to conventional vegetated filter strips. (In progress).
- Evaluation of how BMPs should be designed in areas with cold climates where ice and snow can greatly influence BMP effectiveness. (In progress).
- Assessment of the current state of knowledge about factors that may affect dissolved copper and zinc concentrations in highway stormwater runoff. (In progress).
- WSDOT maintains a test-site in Seattle, with direct piped stormwater runoff from I-5, for partners to

evaluate concentrated-flow treatment BMPs, which are sometimes the only viable options in space-constrained urban settings. (Ongoing).

- Assessment and mitigation of potential environmental impacts of Portland cement concrete highway grindings; to assess the effectiveness of using compost to neutralize slurry pH. Compost was found to be effective at partially neutralizing concrete grinding slurry pH (WSDOT report WA-RD 628.1, 2005).

WSDOT shares its research results with Ecology for consideration for use in Ecology's stormwater management manuals. Research results are also expected to directly benefit WSDOT, as the data will help ensure that the properly selected and sized, and cost-effective facilities are built.

What did WSDOT learn this year and where is WSDOT headed with its monitoring and research programs?

In the 2005-2006 monitoring period, WSDOT further characterized water quality along low ADT, rural highways and gained a better understand the effects of ADT on pollution concentrations in treated runoff. So far, data suggests that ADT alone doesn't have a strong enough influence on treated runoff concentrations to correlate ADT with pollutant concentrations.

We have found that it is very difficult to characterize runoff water quality and flows along rural, low ADT highways because runoff volumes are so small and erratic that our traditionally accepted methods don't work. This year, passive sampling techniques were used to capture "overland flow" in rural areas where composite sampling proved impossible. More data is required to determine the effectiveness of this approach. In order to further characterize runoff from rural, Low ADT highways WSDOT will consider whatever methods prove feasible.

For the first time WSDOT has succeeded in evaluating pollutant loads for BMPs and load reductions were shown to be higher than concentration reductions. As large amounts of water often infiltrate in most BMPs, quantifying load reductions is an important part of documenting the effectiveness of WSDOT's treatment facilities. In the future WSDOT will increasingly strive to quantify pollutant load reduction performance for BMPs, where feasible.

WSDOT's research program will continue 1) studying the effectiveness of BMPs at reducing flows, 2) evaluating the effectiveness of BMPs in areas with cold climates, 3) and quantifying the effectiveness of compost amended vegetated filter strips and 4) studying the factors that affect dissolved copper and zinc in stormwater.

Chapter 7 Stormwater Treatment Facility Construction and Retrofit

How important is stormwater treatment facility construction?

Stormwater treatment facility construction is WSDOT's highest stormwater related priority. As discussed in Chapter 6, treatment facilities remove pollutants and increase compliance with state water quality standards. Treatment facilities are built in tandem with highway construction projects and as stand-alone projects.

What triggers construction projects to include stormwater treatment?

Stormwater treatment facilities are required as a permit condition to treat runoff from new pavement whenever a roadway surface is expanded by more than 5,000 square feet in Western Washington, or when highways are substantially renovated. These facilities treat runoff coming off of the new surface or an equivalent area of nearby impervious surface to remove pollutants and prevent flooding.

The triggers for stormwater treatment are detailed in WSDOT's Highway Runoff Manual at: http://www.wsdot.wa.gov/Environment/waterquality/default.htm which are equivalent to the standards in Ecology's *Stormwater Management Manuals.*

How many and what kind of stormwater BMPs did WSDOT build in the past reporting period?

Exhibit 7-1 provides a summary of BMPs constructed within the general permit areas between July 2005 and June 2006. A description of each BMP type with milepost, offset direction, and facility size (where available) is provided in Appendix 7-A. The number of BMPs constructed in the permit areas was unusually low this year due to construction project end dates not matching up with the reporting period.

Exhibit 7-1

Stormwater Facilities Built Within the NPDES Permit Areas Between July 1, 2005 and June 30, 2006

Project Designation	Number and Type of Structural BMPs Constructed			
	Open Water Detention (1)	Detention Vaults (2)	Infiltration BMP (3)	Linear Treatments (4)
SR 205, Mill Plain Blvd. S. bound off ramp improvement				1
SR161 204th E. to 176th St.E	1		2	4
SR161 234th St. E. to 204th St. E.	5		2	2
SR 512/SR 7 Intersection Safety Improvement				1
Totals	**6**		**4**	**8**

(1) **Open water detention includes detention ponds and wet and dry ponds.**

(2) **Detention vaults include wet vaults and detention pipes.**

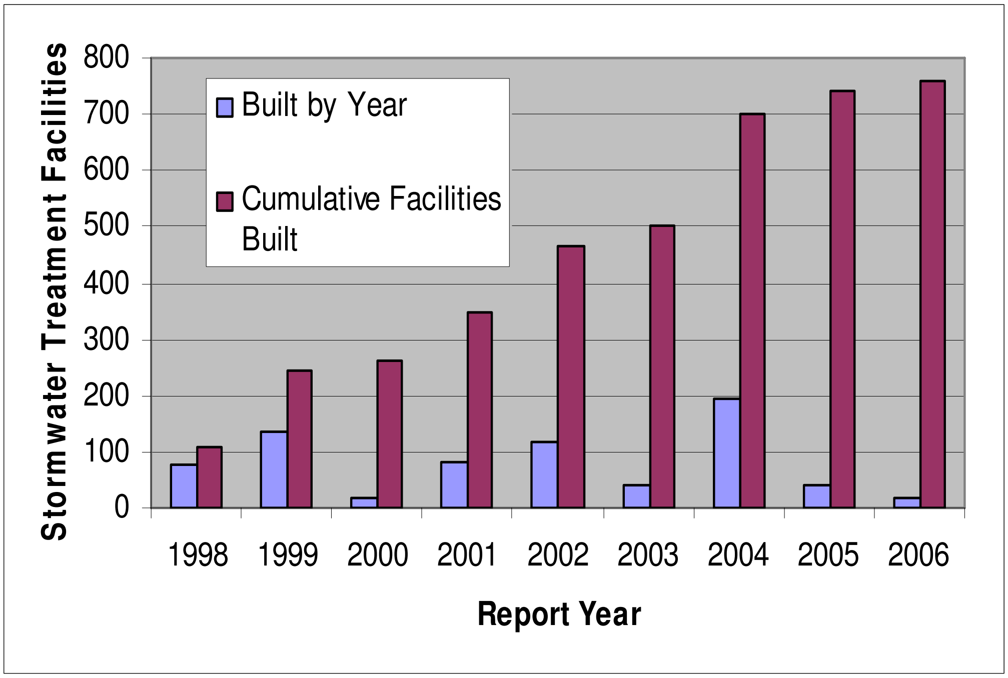
(3) **Infiltration BMPs include infiltration ponds and natural dispersion.**

(4) **Linear treatments include biofiltration swales, ecology embankments and vegetative filter strips.**

How many BMPs has WSDOT built in the permit areas since the permits were issued?

Exhibit 7-2 shows that WSDOT has built 759 stormwater treatment BMPs in the four counties tracked for permit reporting purposes since 1996. While the number of treatment facilities construction varies greatly from year to year, WSDOT is steadily increasing the number of stormwater treatment facilities to treat highway runoff.

Exhibit 7-2
Number of Stormwater Treatment BMPs Built in the Four Stormwater Permit Counties (King, Pierce, Snohomish, and Clark) Since 1996.



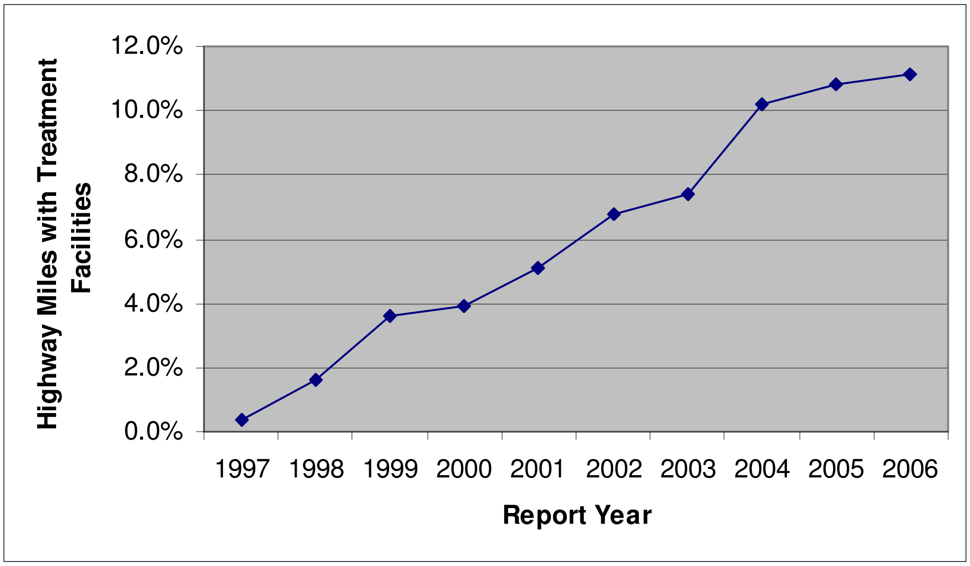
How does the number of treatment facilities built in the stormwater permits areas since 1996 compare to the overall need for stormwater treatment?

Exhibit 7-3 shows that WSDOT provides new treatment facilities for just over 1% of its highway surfaces each year over the last decade. This estimate is based on the assumption that an average of 6 treatment facilities is required for each mile of highway and that there are 1,140 miles of highway within the permitted counties.

Stormwater treatment facilities are built in low points where water collects. For this reason, many of WSDOT's treatment facilities are not readily visible to the driving public.

Exhibit 7-3

Estimated Percent of Highway Miles in Four Counties (King, Pierce, Snohomish, and Clark) With New Stormwater Treatment Facilities Built Since 1996.

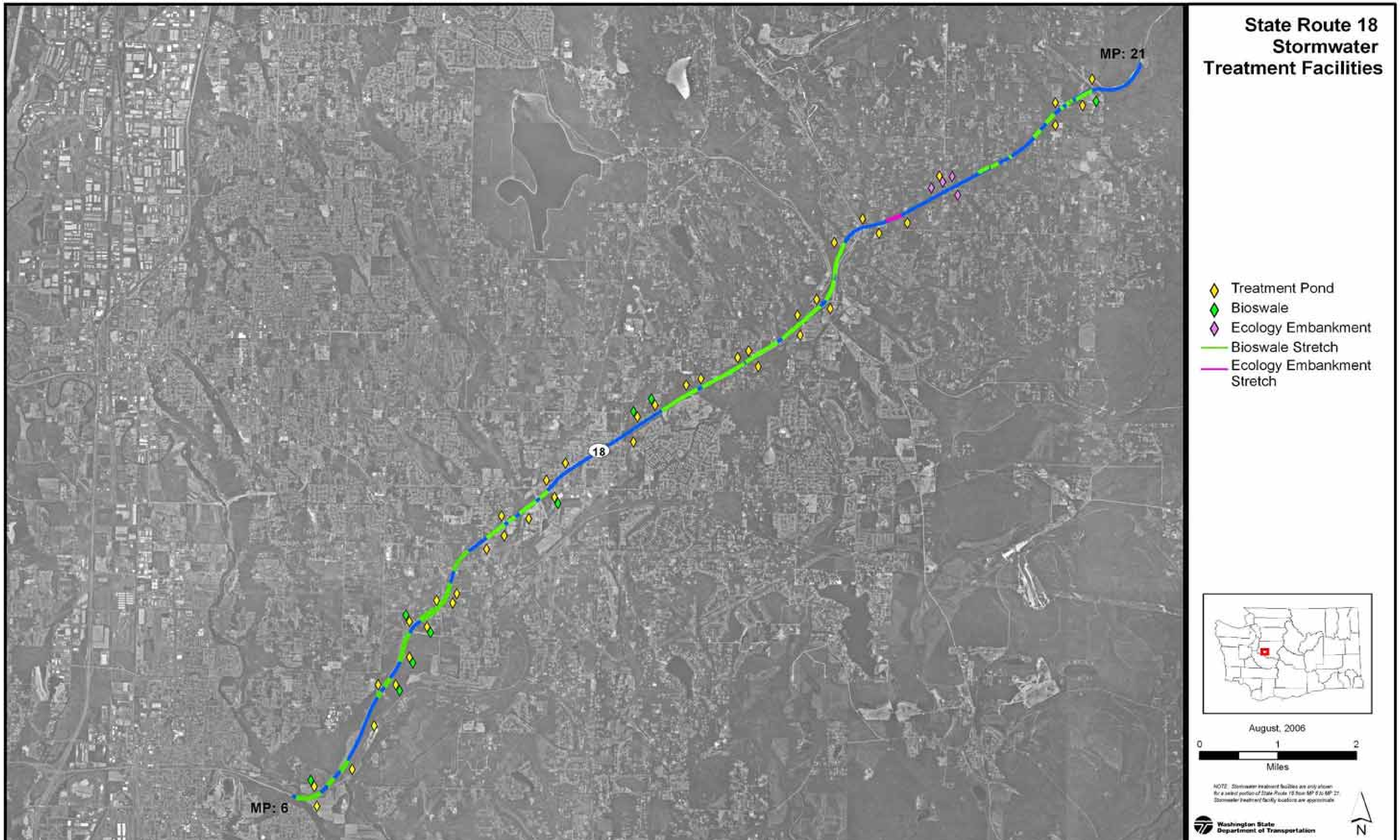


What do all of these stormwater treatment facility construction numbers look like in the real world?

Exhibit 7-4 illustrates the level of investment that WSDOT currently makes to meet stormwater treatment requirements. It shows the locations of 104 BMPs built along a 15-mile stretch of SR 18 in the Auburn-Covington-Maple Valley area during the past 10 years. When one considers that WSDOT has more than 7,000 miles of highway, providing treatment throughout the entire system will be an enormous undertaking.

Exhibit 7-4

State Route 18 Stormwater Treatment Facilities



What is WSDOT's Stormwater Inventory and Retrofit Program and why is it important?

Most highways predate modern water quality regulations and were built without any consideration for water quality. Accordingly, most of WSDOT's older surfaces have no facilities to hold back the stormwater and remove pollutants before letting it enter streams or other sensitive waters. The discrete locations where water leaves highway property are called "outfalls".

It is important to note the stormwater treatment facilities that are built in association with highway expansion projects primarily treat the new road surfaces. They usually don't treat all of the runoff from the adjacent, old highway surfaces.

Fortunately, in some locations the water is naturally treated by roadside vegetation and soils. Many of the older sites lacking treatment facilities, however, are likely letting more pollutants enter our waters than newer sites. Such outfalls are having a larger impact on our waters than they should and need to be fixed or "retrofitted". Outfalls are retrofitted by building ponds and other treatment facilities to remove pollutants before water gets to the outfall.

Stormwater outfalls are places where flowing water leaves the highway and enters 1) streams, lakes, wetlands or any other natural water, 2) a local storm drain system, or 3) groundwater. It is estimated that WSDOT has between 18,000 and 24,000 stormwater outfalls.

Before WSDOT can retrofit the thousands of old outfalls that have no treatment facilities, WSDOT must first inventory and prioritize them. Inventorying outfalls consists of 1) identifying how many outfalls WSDOT has and where they are located, 2) estimating the impacts of each outfall so they can be prioritized for retrofit, and 3) identifying the proper treatment facilities to correct problems at each location. As WSDOT doesn't have the resources to retrofit all of the deficient outfalls at once, the outfalls are prioritized so the largest problems are solved first.

How does WSDOT decide which outfalls should be fixed first?

Numerous factors are considered when prioritizing outfalls for retrofit. In general the strategy is to give priority to outfalls where the most pollution flows into waters that need the most protection. The amount of pollution at a given outfall is estimated based on the size of the area draining to the outfall and multiple other variables. Examples of receiving waters that need the most protection include drinking water supplies and small streams containing critical habitat for endangered fish.

The outfall to McAllister Creek on I-5 by the Nisqually Wildlife Refuge is an example of a high priority outfall. In this case, a long stretch of very heavily traveled highway (lots of dirty water) used to dump untreated water into a relatively small fish-bearing creek. This outfall was retrofitted by building bioswales and composting the highway shoulders.

How much progress have we made and how far do we have to go?

Inventorying, prioritizing, and retrofitting all the outfalls that have been built over nearly a century is a big task that will require substantial resources and time to correct. Nevertheless, WSDOT has made significant steps during this reporting period.

- The locations of 186 outfalls were identified.
- Sufficient data has been collected to prioritize and identify retrofit solutions for 100 outfalls.
- Data packages were prepared to facilitate the scoping of projects to retrofit 102 outfalls.
- $206,000 was spent on a high-priority stand-alone stormwater retrofit project.

Scoping entails developing a preliminary design and budget for a potential project so that it can be considered for funding.

With the work completed in this and past reporting periods WSDOT has:

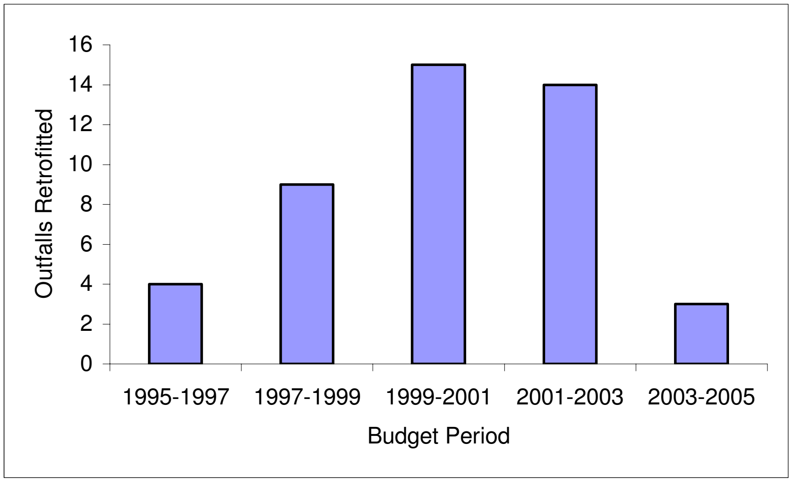
- Inventoried 5,484 of WSDOT's estimated 18,000-24,000 outfalls.
- Prioritized 1,460 outfalls.
- Developed retrofit recommendations for the 460 outfalls where deficiencies need to be eliminated.
- Retrofitted 46 outfalls as stand-alone projects since 1995.

Many old highway segments' outfalls don't need to be retrofitted because the undisturbed roadside vegetation naturally treats the water as well or better than engineered treatment facilities. The best thing that WSDOT can do in such cases is to preserve and manage those areas as natural treatment facilities.

Exhibit 7-5 summarizes stand-alone stormwater retrofit activity since 1995 on a biennial basis. As this report was prepared in the middle of a biennium, 05-7 will be reported next year. It is important to note that variations in funding greatly affect the number of outfalls retrofitted. A temporary increase in funding during the 1999-2001-budget period was responsible for the elevated retrofit rate between 1999 and 2003. Another period of increased retrofits is expected throughout the next several years based on revenue increases passed by the legislature in the spring of 2005. A second variable to consider is that some outfalls are more expensive to fix than others.

It is important to note that WSDOT increasingly retrofits outfalls in conjunction with highway improvement projects to protect endangered fish. As these retrofits activities are embedded within other projects, WSDOT doesn't have a means to track such retrofits. WSDOT needs to develop a means to track retrofit activities that are increasingly included within other project types.

Exhibit 7-5
Outfalls Retrofitted as Stand-Alone Projects

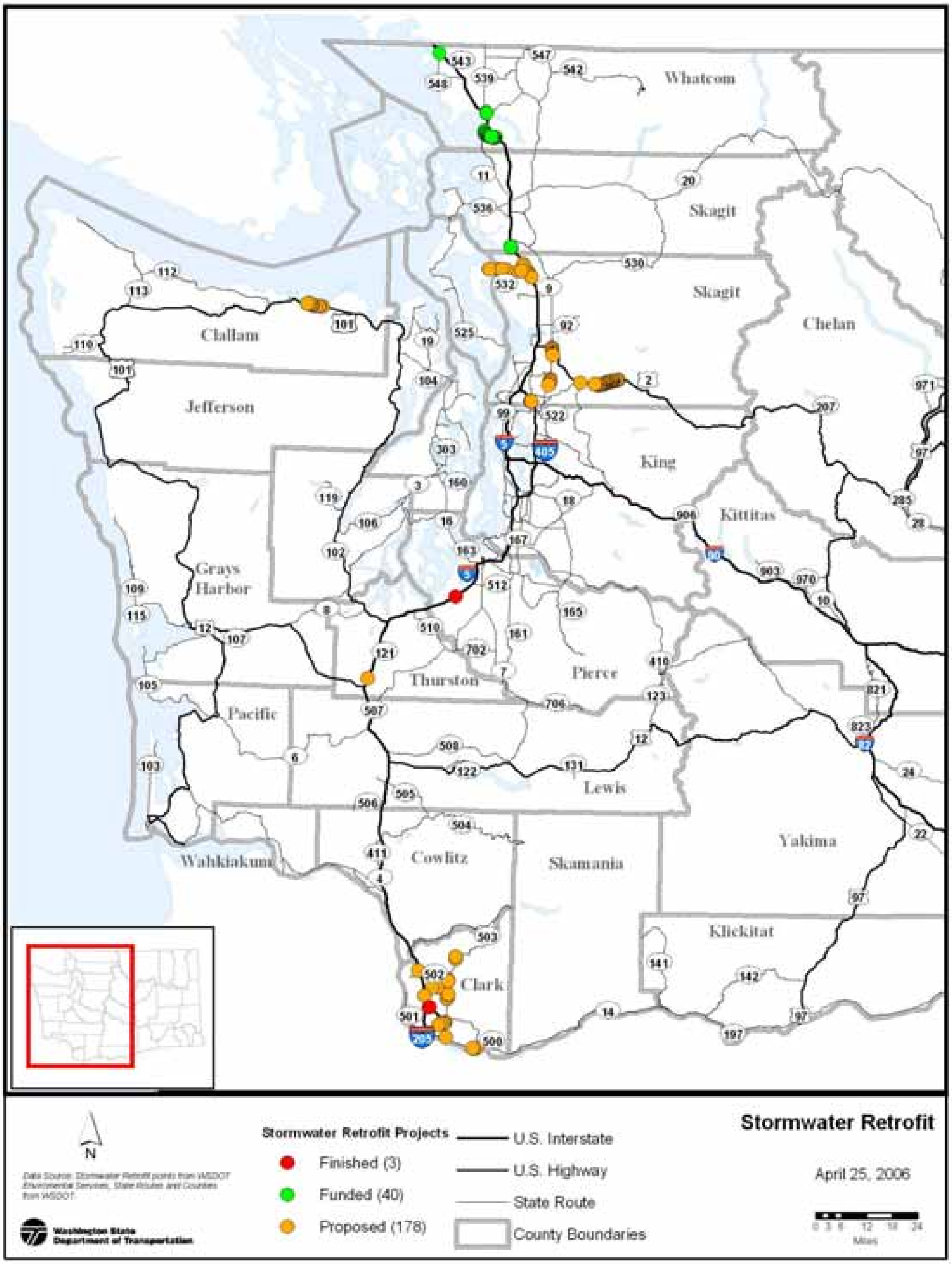


Outfall retrofit costs vary widely based on site-specific conditions. It is important to note that the number of outfalls retrofitted can't be predicted based on funding level as tracked in Exhibit 2-3.

Exhibit 7-6 shows the locations of outfalls that were retrofitted in the 2003-2005 budget period, outfalls that are funded for retrofit and outfalls that have been proposed for retrofit. While WSDOT is steadily increasing the number outfalls that it proposes for retrofit, funding is determined by the legislature and varies in accordance with statewide priorities.

Exhibit 7-6

Stormwater Retrofit Status including outfalls retrofitted in 2003-2005, outfalls that are funded for retrofit, and outfalls that have been proposed for retrofit.



Note: As nearby outfalls overlap when mapped on a large scale this exhibit is only intended to show the general areas where retrofit work is occurring.

What are our plans for the next year?

For the next reporting period, WSDOT intends to inventory and prioritize more outfalls within the permit areas, corresponding with available funding. Due to advances in mapping technologies, WSDOT is developing a screening tool to readily identify areas where high-ranking outfalls are likely to occur. This tool will help WSDOT more efficiently identify the outfalls that need to be retrofitted.

Inventory efforts will be expanded by including multiple WSDOT programs. The Maintenance program is inventorying outfalls in conjunction with facility inspections. Hydraulics engineers inventory and identify outfalls when designing projects. Also, WSDOT's new Roadside Features Inventory Program, whose primary purpose is to identify and eliminate roadside hazards, is also inventorying outfalls. These expanded efforts should increase the rate at which remaining outfalls are inventoried.

WSDOT is planning to expand databases to accommodate additional data requirements for registering dry wells in accordance with the Underground Injection Control rule (WAC 173-218). The regulation is intended to protect groundwater supplies by regulating the "injection" of potentially polluted water into the ground. Some of WSDOT's stormwater infiltration facilities will be regulated under this new rule.

WSDOT has stormwater outfalls called drywells that are regulated by a new Underground Injection Control rule. This rule is intended to protect groundwater quality. Drywells are deep sumps that allow highway runoff to quickly infiltrate into the ground. The Underground Injection Control rule requires WSDOT to register all drywells within the next 5 years.

Chapter 8 Certification

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
MUNICIPAL STORMWATER PERMIT PROGRAM

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fines and imprisonment for willful violations.

Megan White 9/20/06

Megan White, P.E. Date
Environmental Services Office Director
Washington State Department of Transportation

Chapter 9 References

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Appendix 6-A Stormwater Treatment Facility Monitoring Locations

Monitoring Locations

Treatment Facility type	Highway and nearest town	Traffic level (ADT)	Notes:
Bioswale – a broad, grass lined channel	SR 14, MP 10, Vancouver	45,000	The bioswale treats water from approximately 1.4 acres of highway surface consisting of 4 lanes of traffic and a road shoulders plus the narrow embankment between the bioswale and the asphalt. Most of the water is directed to the bioswale via a median barrier and a culvert but water also sheet flows into the BMP.
Bioswale – a broad, grass lined channel	SR 18, MP 13, Maple Valley	2,400	The bioswale treats runoff from approximately 1.8 acres consisting of a lane of highway off ramp and overpass. Runoff reaches the bioswale through a curb & gutter system and a culvert. The bioswale is designed to discharge into an infiltration pond but no runoff was observed reaching the pond as it all infiltrates in the last 50 feet of the bioswale. Runoff is sampled at the bioswale inlet and approximately 150 feet down the bioswale before the water infiltrates.
Bioswale – a broad, grass lined channel	SR 405, MP 26, Bothell	116,000	The bioswale treats runoff from approximately 0.75 acres consisting of 3 lanes of traffic and a road shoulder. Water flows from the roadway into the bioswale. Samples were collected from the bioswale outlet to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from inflow to the closed wet vault located just north of the bioswale.
Compost amended shoulder	I-5, MP 186 "A," Mill Creek	180,000	The BMP treats runoff from approximately 0.3 acres consisting of two lanes of traffic and a road shoulder. As all runoff sheets into the BMP, control samples were collected at a nearby section of curbed highway.
Compost amended shoulder	I-5, MP 186 "B," Mill Creek	180,000	The BMP treats runoff from approximately 0.3 acres consisting of two lanes of traffic and a road shoulder. As all runoff sheets into the BMP, control samples were collected at a nearby section of curbed highway.
Compost amended shoulder	I-5, MP 109, Olympia	88,000	The BMP treats runoff from approximately 1 acre consisting of two lanes of traffic and a road shoulder. Water flows from the roadway through the compost-amended shoulder and ditch. Samples were collected at the end of the ditch to determine effectiveness of the BMP. Samples to characterize the water before treatment were collected just south of the BMP on Interstate 5.
Dry pond - a pond that completely drains between storms	I-5, MP 122, Lakewood	117,000	The pond treats runoff from approximately 8 acres of roadway, median and road shoulder. Water is piped to a vault nearby that collects water until it is pumped to the pond. Samples were collected from the outflow pipe of the pond (although all water was infiltrated and no samples were collected) to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from the inflow pipe to the pond.
Dry Pond – a pond that completely drains between storms	I-5, MP 188, Everett	170,000	The pond treats runoff from approximately 3 acres of roadway and road shoulder. There are two inlets to the pond – one consists of a ditch conveying water from two lanes of southbound traffic and a road shoulder, while water from four lanes of northbound traffic and road shoulder is piped under the roadway into a vegetated ditch. Samples were collected from the pond outlet to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from the vegetated ditch that drains the four lanes of northbound Interstate 5 prior to entering the pond.
Ecology Embankment – a special road shoulder for filtering runoff	SR 167, MP 16, Auburn	115,000	The BMP treats runoff from approximately 0.5 acre consisting of two lanes of traffic and road shoulder. Water sheets off of the pavement into the 500-foot long embankment. Samples were collected from the embankment drainpipe to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from a nearby slot drain at the edge of pavement.

Monitoring Locations

Open vault – a concrete box with no lid	SR 405, MP 30, Bothell	103,000	The vault treats runoff from approximately 7 acres consisting of 6 lanes of traffic. Water is conveyed to the vault under the northbound highway shoulder. The BMP effectiveness samples were collected from the vault outlet pipe. Sample to characterize the water before treatment were collected at a catch basin located approximately 300 feet north of the vault.
Unimproved Grass ditch (not a formal BMP)	SR 405, MP 28, Lynnwood	103,000	The ditch treats runoff from approximately 0.75 acre consisting of two lanes of traffic and the road shoulder. Water flows from the roadway into a 1,500-foot long ditch. Samples were collected at the end of the ditch to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected north of the BMP on State highway.
Unimproved Grass ditch (not a formal BMP)	SR 525, MP 2, Mukilteo	41,000	The ditch treats runoff from approximately 1 acre consisting of two lanes of traffic and road shoulder. Water flows from the roadway into the 245-foot long ditch. Samples were collected at the end of the ditch to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected north of the BMP on State highway.
Vault - a buried concrete box	SR 405, MP 26, Bothell	116,000	The vault treats runoff from approximately 1 acre consisting of 3 lanes of traffic, median, and road shoulder. Water from the roadway flows into a ditch, and via catch basins and pipes is conveyed to the vault under the median. Samples were collected from the vault outlet to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from the inlet to the vault.
Vault - a buried concrete box	SR 525, MP 4, Mukilteo	25,000	The 3-chambered vault treats runoff from approximately 1.8 acres consisting of 4 lanes of traffic. The water flows through a series of catch basins to the vault inlet. The vault inlet was sampled to characterize the water before treatment and the outlet was sampled to determine the effectiveness of the BMP. The vault is located under the southbound shoulder of the highway.
Vegetated Filter Strip - densely vegetated highway shoulder with amended soils	I-5, MP 185, Mill Creek	180,000	The BMP treats runoff from approximately 0.3 acres consisting of two lanes of traffic and a road shoulder. As all runoff sheets into the BMP, control samples were collected at a nearby section of curbed highway.
Wet pond - always contains some water	SR 18, MP 8, Auburn	45,000	The pond treats runoff from approximately 3 acres of impervious and 1 acre of pervious surface consisting of 4 lanes of traffic, shoulders, and a grassy median. The water flows through a series of ditches and pipes to the pond. The pond has a high infiltration capacity and most storms do not generate discharges.
Wet pond - always contains some water	SR 500, MP 5, Vancouver	18,000	The pond treats runoff from approximately 3.2 acres of highway off ramp and 0.5 acres of pervious embankment. Water is collected and conveyed to the pond via curbs and culverts. The pond has a high infiltration rate and it appears that most, if not all, stormwater infiltrates between April and early November.
Wet pond - always contains some water	SR 522, MP 17, Maltby	26,000	The pond treats runoff from approximately 6.6 acres of impervious and 5.4 acres of pervious surfaces consisting of 4 lanes of traffic, highway shoulders, and a wide grassy median. Water flows through a series ditches and pipes to the pond.
Wet pond - always contains some water	SR 525, MP 2 "A," Lynnwood	41,000	The pond treats runoff from approximately 1.3 acres of impervious and .3 acres of pervious surface consisting of 4 lanes of traffic, highway shoulders, and a roadside ditch. Most water flows through a series ditches and pipes to the pond but some runoff sheets directly into the pond.
Wet pond - always contains some water	SR 525, MP 2 "B," Mukilteo	41,000	The pond treats runoff from approximately 1 acre of pervious surface consisting of 4 lanes of traffic and highway shoulders. The water flows through a series of ditches and pipes to the pond.

Monitoring Locations

Wet pond - always contains some water	SR 525, MP 3, Mukilteo	30,000	The pond treats runoff from approximately 1.5 to 2 acres consisting of 4 lanes of traffic. The water flows through a series of catch basins and pipes to the pond inlet.
Wet pond – always contains some water	I-5, MP 96, Maytown	59,000	The pond treats runoff from approximately 8 acres of land including six lanes of traffic, highway shoulders and a grassy median. The water flows though a series of catch basins and pipes to the pond. The wet pond inlet was sampled to characterize the water before treatment and the outlet was sampled to determine the effectiveness of the BMP.

Appendix 6-B Stormwater Treatment Facility Effectiveness, Composite Sampling Data

Composite Sampling Data

Total Cu, Total Zn, Dis. Cu, and Dis. Zn concentrations are in ug/L.
TP stands for Total Phosphorus, concentrations in mg/L.
TSS stands for Total Suspended Solids, concentrations in mg/L.
HA stands for hardness, concentrations in mg $CaCO_3$/L.

NS means no sample was collected.
NF means no flow, all water infiltrated within the BMP.
Values in grey represent No Detection and are reported as half the detection limit.

Wet Pond I-5 MP 96

Untreated Runoff: Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA	Treated Runoff: Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/17/03	0.070	12.0	7.4	86	3.6	64	18.0	11/17/03	0.005	6.0	6.6	50	4.7	41	21.0
11/25/03	0.130	49.0	20.0	130	3.9	64	16.0	11/25/03	0.120	4.0	8.1	74	3.6	44	23.0
11/28/03	0.077	42.0	17.0	84	4.2	44	10.0	11/28/03	0.022	3.8	9.0	55	3.4	38	24.0
12/5/03	0.116	72.0	17.0	130	3.5	61	25.0	12/5/03	0.022	2.5	5.2	51	2.7	36	23.0
12/13/03	0.081	47.0	14.0	98	2.8	57	15.0	12/13/03	0.020	2.0	4.8	36	3.6	30	27.0
1/23/04	0.123	37.0	18.0	140	5.0	63	50.0	1/23/04	0.024	4.0	6.4	66	3.8	40	41.0
1/28/04	0.240	160.0	42.0	180	3.5	54	28.0	1/28/04	0.023	1.2	4.8	38	3.2	28	36.0
3/5/04	0.177	88.0	29.0	180	5.6	72	37.0	3/5/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
3/19/04	0.090	110.0	38.0	230	14.0	100	43.0	3/19/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
3/24/04	0.230	81.0	27.0	160	5.6	59	27.0	3/24/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
9/11/04	0.041	29.0	9.0	105	3.7	71	16.5	9/11/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
10/8/04	0.089	66.0	24.0	140	6.3	68	25.0	10/8/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
10/30/04	0.067	56.0	13.5	115	2.75	57	25.0	10/30/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
11/2/04	0.108	67.0	17.0	125	3.0	59	23.0	11/2/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
11/18/04	0.220	240.0	36.0	210	3.6	66	28.0	11/18/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
11/26/04	0.057	73.0	16.5	105	2.2	56	14.0	11/26/04	0.034	14.0	8.0	60	4.3	37	22.0
12/9/04	0.160	130.0	35.0	200	3.8	86	38.0	12/9/04	0.019	2.8	7.7	50	3.8	33	27.0
1/17/05	0.220	200.0	33.0	180	1.9	43	18.0	1/17/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
1/18/05	NS	NS	NS	NS	NS	NS	NS	1/18/05	0.063	18.0	9.8	66	2.6	37	23.0
Samples	18	18	18	18	18	18	18	Samples	10	10	10	10	10	10	10
Maximum	0.240	240.0	42.0	230	14.0	100	50.0	Maximum	0.120	18.0	9.8	74	4.7	44	41.0
Minimum	0.041	12.0	7.4	84	1.9	43	10.0	Minimum	0.019**	1.2	4.8	36	2.6	28	21.0
Mean	0.128	86.6	23.0	144	4.4	64	25.4	Mean	0.035	5.8	7.0	55	3.6	36	26.7

*All runoff infiltrated on these dates. However, it is not known how these events effected average pollutant concentrations leaving the BMP. Therefore, they were not factored into the overall BMP pollutant reduction comparisons (Max, Min, and Mean values).

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Wet Pond SR 525 MP 2 "A"

Untreated Runoff: Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA	Treated Runoff: Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/25/05	0.139	135.0	11.2	39	5.5	15	28.3	11/25/05	0.050	7.5	6.3	24	4.8	18	27.6
11/27/05	NS	NS	NS	NS	NS	NS	NS	11/27/05	0.047	4.8	5.1	29	5.0	22	26.0
12/28/05	0.106	109.0	15.2	89	4.7	31	26.0	12/28/05	0.026	3.5	2.7	19	2.7	17	28.3
12/29/05	0.062	62.0	12.0	47	3.9	27	31.9	12/29/05	0.023	3.8	3.4	22	2.8	20	31.5
1/5/06	NS	NS	NS	NS	NS	NS	NS	1/5/06	0.032	7.3	6.0	34	4.1	30	29.1
1/7/06	0.110	84.0	16.7	95	4.7	37	27.8	1/7/06	0.029	4.5	3.8	31	3.2	29	28.1
1/10/06	NS	NS	NS	NS	NS	NS	NS	1/10/06	0.037	9.0	3.6	29	2.8	9	25.0
1/12/06	0.093	57.0	7.1	314	4.5	13	30.3	1/12/06	0.032	6.3	3.5	23	2.6	13	28.5
1/20/06	0.040	26.0	4.3	31	2.4	19	26.6	1/20/06	0.021	2.8	2.3	26	2.0	19	30.9
1/28/06	0.121	105.0	15.8	71	3.4	21	18.2	1/28/06	0.027	8.0	4.0	23	3.1	24	30.7
1/31/06	0.044	27.0	7.8	49	5.1	33	24.8	1/31/06	0.027	6.5	3.0	22	2.5	10	24.0
2/23/06	0.100	60.0	14.9	54	4.8	20	26.6	2/23/06	0.040	6.0	5.6	53	4.8	47	34.6
2/28/06	0.085	33.0	17.3	74	6.5	27	29.3	2/28/06	0.041	5.5	6.0	47	4.6	39	31.3
3/7/06	0.177	106.0	31.7	251	6.2	66	20.5	3/7/06	0.031	5.5	3.3	76	3.0	75	30.7
Samples	11	11	11	11	11	11	11	Samples	14	14	14	14	14	14	14
Maximum	0.177	135.0	31.7	314	6.5	66	31.9	Maximum	0.050	9.0	6.3	76	5.0	75	34.6
Minimum	0.040	26.0	4.3	31	2.4	13	18.2	Minimum	0.021	2.8	2.3	19	2.0	9	24.0
Mean	0.098	73.1	14.0	101	4.7	28	26.4	Mean	0.033	5.8	4.2	33	3.4	27	29.0

Composite Sampling Data

Wet Pond SR 525 MP 2 "B"

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/13/05	0.093	60.0	18.3	88	4.2	21	18.8		11/13/05	0.042	7.5	6.0	23	4.5	18	45.9
11/25/05	0.111	78.0	21.5	88	4.8	13	18.4		11/25/05	NS	NS	NS	NS	NS	NS	NS
11/27/05	0.184	41.0	12.2	92	4.2	39	44.4		11/27/05	0.048	10.0	5.6	39	2.6	30	133.0
12/19/05	0.354	380.0	44.3	251	6.8	14	57.9		12/19/05	0.052	4.5	3.1	60	2.1	50	122.0
12/21/05	0.431	276.0	40.3	194	4.0	13	55.9		12/21/05	0.072	16.0	5.2	58	2.3	40	118.0
12/23/05	0.120	70.0	18.2	94	5.9	20	78.4		12/23/05	NS	NS	NS	NS	NS	NS	NS
12/28/05	0.120	66.0	15.6	83	3.8	19	42.4		12/28/05	0.071	9.5	4.3	54	2.3	42	76.8
1/5/06	0.179	130.0	24.1	137	3.7	16	38.7		1/5/06	0.058	16.0	4.7	94	3.7	75	62.7
1/7/06	NS	NS	NS	NS	NS	NS	NS		1/7/06	0.050	13.0	6.4	115	4.0	80	64.9
1/10/06	0.086	45.0	9.9	52	3.5	2.5	51.0		1/10/06	0.047	14.0	6.5	47	2.7	7	52.8
1/12/06	0.143	51.0	16.7	80	4.6	2.5	49.4		1/12/06	0.046	11.0	3.4	41	3.3	9	59.6
1/20/06	0.064	39.0	5.6	31	1.8	2.5	47.7		1/20/06	0.037	7.5	3.0	48	2.3	24	64.9
1/27/06	0.102	92.0	14.7	80	2.3	19	18.8		1/27/06	0.036	11.0	4.0	41	3.0	45	75.4
1/31/06	0.051	31.0	8.2	34	3.5	17	127.0		1/31/06	0.038	15.0	4.3	35	2.6	28	40.1
Samples	13	13	13	13	13	13	13		Samples	12	12	12	12	12	12	12
Maximum	0.431	380.0	44.3	251	6.8	39	127.0		Maximum	0.072	16.0	6.5	115	4.5	80	133.0
Minimum	0.051	31.0	5.6	31	1.8	3	18.4		Minimum	0.036	4.5	3.0	23	2.1	7	40.1
Mean	0.157	104.5	19.2	100	4.1	15	49.9		Mean	0.050	11.3	4.7	55	3.0	37	76.3

Wet Pond SR 525 MP 3

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	NS	NS	NS	NS	NS	NS	NS		10/25/04	0.005**	1.6	1.6	13	1.5	8.3	51.0
11/1/04	0.005**	14.0	16.0	73	5.5	21	55.0		11/1/04	NS	NS	NS	NS	NS	NS	NS
11/2/04	NS	NS	NS	NS	NS	NS	NS		11/2/04	0.005**	1.6	1.4	8.4	1.6	6.9	44.0
11/16/04	0.051	4.6	9.4	54	7.2	26	79.0		11/16/04	0.005**	1.4	1.2	33	0.5	19	59.0
11/18/04	0.100	11.0	16.0	97	3.9	25	52.0		11/18/04	0.010	1.4	2.1	20	1.1	12	47.0
11/24/04	0.140	66.0	25.0	180	7.5	60	77.0		11/24/04	0.016	1.0	2.0	32	1.5	28	53.0
11/30/04	0.028	35.0	14.0	88	2.4	14	33.0		11/30/04	0.005**	1.2	3.0	23	2.7	12	46.0
12/6/04	0.033	24.0	14.0	85	6.7	42	99.0		12/6/04	0.005**	1.4	1.9	32	1.3	25	57.0
12/10/04	0.130	69.0	26.0	140	4.2	30	58.0		12/10/04	NS	NS	NS	NS	NS	NS	NS
12/21/05	0.110	38.0	18.0	97	4.6	23	87.0		12/21/05	0.015	2.8	1.2	21	1.4	14	59.0
12/30/04	0.024	5.6	5.8	44	3.2	22	63.0		12/30/04	0.021	2.0	0.5	17	0.5	8.2	51.0
2/4/05	0.100	37.0	23.0	88	6.8	20	27.0		2/4/05	0.015	4.8	1.7	22	1.2	7.9	79.0
3/17/05	0.072	54.0	41.0	160	13.0	39	29.0		3/17/05	0.022	3.6	1.6	73	0.5	59	120.0
3/28/05	0.048	18.0	16.0	57	12.0	37	93.0		3/28/05	0.014	2.4	3.4	29	2.8	23	85.0
4/8/05	0.074	51.0	22.0	94	6.9	28	55.0		4/8/05	0.005**	1.6	2.7	13	2.1	7.3	50.0
Samples	12	13	13	13	13	13	13		Samples	13	13	13	13	13	13	13
Maximum	0.140	69.0	41.0	180	13.0	60	99.0		Maximum	0.022**	4.8	3.4	73	2.8	59	120.0
Minimum	0.024	4.6	5.8	44	2.4	14	27.0		Minimum	0.010	1.0	1.2**	8	1.1**	7	44.0
Mean	0.070**	32.9	18.9	97	6.5	30	62.1**		Mean	0.011**	2.1	1.9	26	1.4	18	61.6**

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Wet Pond SR 18 MP 8

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
2/28/06	0.125	60.0	16.2	87	5.3	21	29.9		2/28/06	NF*	NF*	NF*	NF*	NF*	NF*	NF*
3/14/06	0.797	672.0	102.9	405	12.2	50	36.2		3/14/06	NF*	NF*	NF*	NF*	NF*	NF*	NF*
4/29/06	0.078	11.0	7.1	26	6.8	19	12.7		4/29/06	0.039	4.5	2.4	10	2.0	8	53.2
Samples	3	3	3	3	3	3	3		Samples	1	1	1	1	1	1	1
Maximum	0.797	672.0	102.9	405	12.2	50	36.2		Maximum	0.039	4.5	2.4	10	2.0	8	53.2
Minimum	0.078	11.0	7.1	26	5.3	19	12.7		Minimum	0.039	4.5	2.4	10	2.0	8	53.2
Mean	0.333	247.7	42.1	173	8.1	30	26.3		Mean	0.039	4.5	2.4	10	2.0	8	53.2

*All runoff infiltrated on these dates. However, it is not known how these events effected average pollutant concentrations leaving the BMP. Therefore, they were not factored into the overall BMP pollutant reduction comparisons (Max, Min, and Mean values).

Composite Sampling Data

Wet Pond SR 500 MP 5

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
01/12/06	0.043	26.4	11.0	79	3.9	44	23.9		01/12/06	0.0045	1.1	4.0	22	2.0	12	42.1
01/16/06	0.100	96.0	15.8	98	3.2	36	23.2		01/16/06	0.028	1.1	2.9	21	3.8	29	51.8
01/17/06	NS	NS	NS	NS	NS	NS	NS		01/17/06	0.026	1.1	5.0	42	2.9	26	40.6
01/20/06	0.161	126.0	19.7	131	2.5	40	23.8		01/20/06	0.032	4.4	13.6	56	9.5	38	49.6
01/28/06	0.058	41.6	11.9	81	2.6	28	11.5		01/28/06	0.0045	1.1	2.8	11	1.9	13	49.9
01/29/06	0.056	59.6	14.9	83	7.2	51	9.5		01/29/06	0.0045	4.8	3.0	15	1.1	11	43.6
01/31/06	0.091	55.2	15.1	87	3.7	47	20.5		01/31/06	0.044	12.0	3.3	15	2.5	18	35.8
02/27/06	0.038	50.0	14.2	85	10.7	63	23.3		02/27/06	0.134	10.8	6.3	25	3.4	16	60.2
03/05/06	0.049	28.4	8.6	58	7.1	50	16.7		03/05/06	0.043	4.0	4.0	18	2.5	11	48.3
03/08/06	0.179	100.0	26.5	128	5.0	35	13.5		03/08/06	0.038	2.7	3.1	12	1.7	8	48.1
03/16/06	0.168	99.6	20.5	128	6.3	49	31.4		03/16/06	0.033	2.2	6.8	35	2.0	9	48.9
Samples	10	10	10	10	10	10	10		Samples	11	11	11	11	11	11	11
Maximum	0.179	126.0	26.5	131	10.7	63	31.4		Maximum	0.134	12.0	13.6	56	9.5	38	60.2
Minimum	0.038	26.4	8.6	58	2.5	28	9.5		Minimum	0.026	2.2	2.8	11	1.1	8	35.8
Mean	0.094	68.3	15.8	96	5.2	44	19.7		Mean	0.036	4.1	5.0	25	3.0	17	47.2

Wet Pond SR 522 MP 17

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/11/05	NS	NS	NS	NS	NS	NS	NS		11/11/05	0.038	11.0	7.0	26	4.4	18	17.6
11/25/05	0.142	210.0	18.3	115	3.3	12	14.5		11/25/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
11/29/05	NS	NS	NS	NS	NS	NS	NS		11/29/05	0.036	6.0	4.7	29	4.0	28	28.7
12/19/05	0.685	612.0	49.5	381	6.6	19	80.3		12/19/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
12/21/05	0.323	254.0	33.4	177	3.0	15	30.3		12/21/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
12/22/05	0.536	620.0	33.4	229	3.8	16	24.6		12/22/05	0.085	27.0	6.4	47	4.1	25	43.4
1/5/06	0.452	380.0	34.2	351	2.8	64	20.9		1/5/06	0.029	6.3	6.0	20	2.5	15	14.9
1/10/06	0.099	68.0	4.1	112	2.7	24	25.8		1/10/06	0.032	11.0	3.4	23	2.6	2.5	15.6
1/12/06	NS	NS	NS	NS	NS	NS	NS		1/12/06	0.031	7.3	3.0	26	2.5	6	13.1
1/19/06	0.301	343.0	24.1	265	1.5	49	18.6		1/19/06	0.037	5.0	3.0	15	2.0	7	12.5
1/25/06	1.570	1246.0	71.5	548	2.2	27	28.9		1/25/06	0.023	4.5	3.0	16	2.1	13	13.3
1/27/06	0.260	273.0	23.5	243	1.8	55	14.3		1/27/06	0.045	10.5	3.7	16	2.7	14	15.2
1/31/06	0.217	246.0	19.6	583	2.2	49	83.6		1/31/06	0.038	15.0	3.8	16	2.4	11	13.3
2/23/06	0.324	259.0	27.9	149	5.0	17	16.2		2/23/06	0.085	17.0	6.7	20	2.9	11	12.9
2/27/06	0.257	168.0	28.0	170	4.7	20	26.8		2/27/06	0.069	22.0	8.5	37	3.8	16	26.8
Samples	12	12	12	12	12	12	12		Samples	12	12	12	12	12	12	12
Maximum	1.570	1246.0	71.5	583	6.6	64	83.6		Maximum	0.085	27.0	8.5	47	4.4	28	43.4
Minimum	0.099	68.0	4.1	112	1.5	12	14.3		Minimum	0.023	4.5	3.0	15	2.0	6	12.5
Mean	0.431	389.9	30.6	277	3.3	31	32.1		Mean	0.046	11.9	4.9	24	3.0	14	18.9

*All runoff infiltrated on these dates. However, it is not known how these events effected average pollutant concentrations leaving the BMP. Therefore, they were not factored into the overall BMP pollutant reduction comparisons (Max, Min, and Mean values).

Bioswale SR 14 MP 10

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/1/05	0.103	53.6	17.2	81	4.5	34	16.4		12/1/05	NS	NS	NS	NS	NS	NS	NS
12/21/05	NS	NS	NS	NS	NS	NS	NS		12/21/05	0.126	14.8	11.2	44	6.6	34	39.8
1/6/06	0.112	62.8	14.9	57	6.2	36	12.6		1/6/06	0.083	20.9	10.2	24	4.4	19	17.2
1/9/06	0.079	41.2	13.2	54	3.2	19	10.7		1/9/06	0.080	11.6	6.0	24	3.9	12	15.5
1/12/06	0.065	47.2	15.5	56	4.0	22	9.6		1/12/06	0.057	15.6	8.0	61	3.5	17	12.7
1/16/06	0.131	71.2	16.2	64	5.4	26	10.2		1/16/06	0.082	22.4	8.1	30	5.9	20	12.8
1/17/06	NS	NS	NS	NS	NS	NS	NS		1/17/06	0.089	18.0	11.7	65	4.2	20	10.7
1/27/06	0.133	92.8	19.5	84	3.3	23	8.8		1/27/06	0.132	48.4	11.5	43	3.2	15	11.3
1/29/06	0.056	33.6	9.8	38	3.1	17	5.0		1/29/06	0.064	9.2	5.7	17	2.6	11	7.8
1/31/06	0.118	75.2	21.4	71	3.9	26	12.3		1/31/06	0.084	22.8	8.1	27	5.0	23	11.7
2/28/06	0.155	77.6	22.8	91	6.2	42	17.8		2/28/06	0.056	14.0	11.3	41	3.8	23	24.1
3/5/06	0.110	71.6	13.9	60	5.8	32	14.6		3/5/06	0.106	30.4	9.1	40	6.8	43	23.8
Samples	10	10	10	10	10	10	10		Samples	11	11	11	11	11	11	11
Maximum	0.155	92.8	22.8	91	6.2	42	17.8		Maximum	0.132	48.4	11.7	65	6.8	43	39.8
Minimum	0.056	33.6	9.8	38	3.1	17	5.0		Minimum	0.056	9.2	5.7	17	2.6	11	7.8
Mean	0.106	62.7	16.4	66	4.6	27	11.8		Mean	0.087	20.7	9.2	38	4.6	21	17.0

Composite Sampling Data

Bioswale SR 18 MP 13

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
2/27/06	0.312	186.0	25.7	188	5.1	22	32.1
3/8/06	0.123	47.0	9.4	120	3.7	37	21.5
4/13/06	0.084	28.0	5.4	31	2.6	15	11.5
4/21/06	0.347	189.0	22.4	130	1.8	6	14.7
Samples	4	4	4	4	4	4	4
Maximum	0.347	189.0	25.7	188	5.1	37	32.1
Minimum	0.084	28.0	5.4	31	1.8	6	11.5
Mean	0.217	112.5	15.7	117	3.3	20	20.0

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
2/27/06	0.115	12.0	8.3	33	4.9	17	10.9
3/8/06	NS	NS	NS	NS	NS	NS	NS
4/13/06	0.098	15.0	6.8	28	5.7	23	15.0
4/21/06	0.074	5.8	4.6	19	4.1	17	13.3
Samples	3	3	3	3	3	3	3
Maximum	0.115	15.0	8.3	33	5.7	23	15.0
Minimum	0.074	5.8	4.6	19	4.1	17	10.9
Mean	0.096	10.9	6.6	27	4.9	19	13.1

Dry Pond I-5 MP 122 (all water infiltrated)

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/10/04	0.016	25.0	13.5	135	3.4	80.5	13.5
12/13/04	0.120	86.0	28.0	210	5.2	110	20.0
1/17/05	0.230	185.0	45.0	163	3.6	77.5	20.0
1/18/05	0.110	76.0	22.0	130	1.4	46	9.5
Samples	4	4	4	4	4	4	4
Maximum	0.230	185.0	45.0	210	5.2	110	20.0
Minimum	0.016	25.0	13.5	130	1.4	46	9.5
Mean	0.119	93.0	27.1	160	3.4	79	15.8

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/10/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
12/13/04	NF*	NF*	NF*	NF*	NF*	NF*	NF*
1/17/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
1/18/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
Samples	0	0	0	0	0	0	0
Maximum	0.000	0.0	0.0	0	0.0	0	0.0
Minimum	0.000	0.0	0.0	0	0.0	0	0.0
Mean	0.000	0.0	0.0	0	0.0	0	0.0

*All runoff infiltrated for this BMP. Outflowing pollutant loads were completely eliminated due to infiltration. Therefore, the "0" values for effluent pollutant concentrations were factored into the overall BMP pollutant reduction comparisons (Max, Min, and Mean values).

Chambered Vault SR 525 MP 4

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.022	3.4	5.2	39	4.3	24	150.0
11/1/04	0.005**	3.8	4.9	50	3.1	30	160.0
11/2/04	NS	NS	NS	NS	NS	NS	NS
11/16/04	0.005**	1.0	2.3	34	1.2	17	160.0
12/9/04	NS	NS	NS	NS	NS	NS	NS
12/10/04	NS	NS	NS	NS	NS	NS	NS
12/21/05	0.010	3.0	1.1	26	1.2	14	140.0
12/30/04	0.120	66.0	17.0	110	1.7	25	36.0
3/28/05	0.039	10.0	17.0	54	11.0	34	29.0
4/8/05	0.440	310.0	65.0	350	8.5	42	49.0
5/16/05	0.270	100.0	34.0	170	9.1	37	28.0
5/18/05	0.049	10.0	12.0	56	6.6	32	23.0
Samples	9	9	9	9	9	9	9
Maximum	0.440	310.0	65.0	350	11.0	42	160.0
Minimum	0.010	1.0	1.1	26	1.2	14	23.0
Mean	0.107**	56.4	17.6	99	5.2	28	86.1

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.005**	0.4	2.9	39	2.9	22	43.0
11/1/04	NS	NS	NS	NS	NS	NS	NS
11/2/04	0.039	10.0	3.9	45	1.9	22	52.0
11/16/04	0.027	1.8	3.6	58	2.0	34	100.0
12/9/04	0.005**	4.0	3.9	48	2.1	30	49.0
12/10/04	0.014	4.0	5.0	53	1.4	34	41.0
12/21/05	NS	NS	NS	NS	NS	NS	NS
12/30/04	0.039	2.6	2.1	47	0.6	28	51.0
3/28/05	0.024	10.0	9.4	50	6.3	31	43.0
4/8/05	0.026	13.0	8.0	60	2.8	30	42.0
5/16/05	NS	NS	NS	NS	NS	NS	NS
5/18/05	0.027	3.0	6.3	33	3.9	23	35.0
Samples	9	9	9	9	9	9	9
Maximum	0.039**	13.0	9.4	60	6.3	34	100.0
Minimum	0.014	1.8**	2.1	33	0.6	22	35.0
Mean	0.023**	5.4	5.0	48	2.7	28	50.7**

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Closed Vault SR 405 MP 26

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/13/03	0.017	0.87	4.6	18	2.7	8.9	37.0
12/16/03	0.021	1.2	3.9	24	3.2	20	37.0
1/8/04	0.048	4.5	5.5	42	3.8	38	45.0
1/15/04	0.019	3.6	4.4	29	3.5	18	34.0
1/26/04	0.028	3.3	4.5	17	4.4	16	28.0
1/30/04	NS	NS	NS	NS	NS	NS	NS
2/17/04	NS	NS	NS	NS	NS	NS	NS
Samples	5	5	5	5	5	5	5
Maximum	0.048	4.5	5.5	42	4.4	38	45.0
Minimum	0.017	0.9	3.9	17	2.7	9	28.0
Mean	0.027	2.7	4.6	26	3.5	20	36.2

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/13/03	NS	NS	NS	NS	NS	NS	NS
12/16/03	0.026	1.5	4.4	33	3.8	18	37.0
1/8/04	0.048	5.0	4.4	47	3.7	47	38.0
1/15/04	0.010	2.9	3.2	23	2.8	16	33.0
1/26/04	0.053	14.0	5.4	26	5.0	19	22.0
1/30/04	0.048	12.0	4.1	19	3.3	13	22.0
2/17/04	0.027	1.8	3.9	17	2.9	11	32.0
Samples	6	6	6	6	6	6	6
Maximum	0.053	14.0	5.4	47	5.0	47	38.0
Minimum	0.010	1.5	3.2	17	2.8	11	22.0
Mean	0.035	6.2	4.2	28	3.6	21	30.7

Composite Sampling Data

Open Vault SR 405 MP 30

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/16/03	NS	NS	NS	NS	NS	NS	NS
12/20/03	NS	NS	NS	NS	NS	NS	NS
1/8/04	2.050	1416.0	220.0	1200	18.0	68	94.0
1/15/04	0.146	86.0	38.0	250	9.4	74	69.0
1/26/04	0.664	792.0	61.0	350	2.0	27	17.0
1/30/04	0.259	290.0	35.0	190	4.7	45	18.0
2/9/04	NS	NS	NS	NS	NS	NS	NS
2/16/04	NS	NS	NS	NS	NS	NS	NS
2/17/04	NS	NS	NS	NS	NS	NS	NS
2/27/04	NS	NS	NS	NS	NS	NS	NS
3/4/04	0.127	83.0	28.0	130	8.5	46	30.0
10/25/04	0.020	13.0	18.0	100	9.7	61	30.0
11/1/04	0.230	16.0	11.0	55	7.1	39	23.0
11/2/04	0.130	110.0	23.0	120	2.4	24	9.3
11/16/04	0.160	13.0	38.0	180	10.0	66	29.0
11/24/04	0.160	96.0	41.0	210	10.0	94	31.0
11/30/04	0.085	3.4	21.0	120	8.6	71	32.0
12/6/04	0.042	87.0	28.0	170	5.7	60	41.0
12/9/04	0.170	120.0	39.0	200	5.9	60	23.0
12/10/04	0.150	83.0	46.0	210	8.3	68	35.0
12/30/04	0.120	120.0	50.0	250	14.0	100	50.0
2/4/05	0.190	92.0	42.0	170	8.3	31	21.0
3/17/05	0.057	40.0	22.0	100	9.8	36	58.0
3/21/05	0.160	130.0	32.0	130	17.0	63	55.0
3/28/05	0.012	20.0	12.0	48	8.0	30	13.0
3/29/05	0.056	24.0	17.0	86	9.2	45	78.0
4/8/05	0.170	72.0	29.0	130	12.0	53	46.0
4/11/05	0.020	2.8	10.0	53	5.7	28	21.0
5/18/05	0.110	5.2	27.0	91	13.0	50	23.0
Samples	23	23	23	23	23	23	23
Maximum	2.050	1416.0	220.0	1200	18.0	100	94.0
Minimum	0.012	2.8	10.0	48	2.0	24	9.3
Mean	0.230	161.5	38.6	198	9.0	54	36.8

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/16/03	0.044	7.5	12.0	67	7.1	52	35.0
12/20/03	0.047	15.0	11.0	74	6.2	48	35.0
1/8/04	NS	NS	NS	NS	NS	NS	NS
1/15/04	NS	NS	NS	NS	NS	NS	NS
1/26/04	NS	NS	NS	NS	NS	NS	NS
1/30/04	NS	NS	NS	NS	NS	NS	NS
2/9/04	0.044	12.0	12.0	71	8.5	47	41.0
2/16/04	0.035	6.4	10.0	57	7.8	41	42.0
2/17/04	0.052	9.7	12.0	64	7.8	41	42.0
2/27/04	0.073	18.0	13.0	73	7.0	44	48.0
3/4/04	0.081	14.0	11.0	59	6.9	39	44.0
10/25/04	NS	NS	NS	NS	NS	NS	NS
11/1/04	NS	NS	NS	NS	NS	NS	NS
11/2/04	NS	NS	NS	NS	NS	NS	NS
11/16/04	NS	NS	NS	NS	NS	NS	NS
11/24/04	0.040	18.0	14.0	67	7.3	53	31.0
11/30/04	0.005**	6.2	11.0	48	8.2	38	30.0
12/6/04	0.005**	5.0	8.6	59	6.3	46	37.0
12/9/04	0.036	6.0	9.5	61	6.0	39	39.0
12/10/04	0.050	9.0	13.0	58	6.9	43	36.0
12/30/04	0.044	12.0	11.0	70	5.7	49	34.0
2/4/05	0.059	27.0	18.0	100	9.1	50	75.0
3/17/05	NS	NS	NS	NS	NS	NS	NS
3/21/05	0.062	11.0	13.0	53	8.7	28	62.0
3/28/05	0.011	3.8	11.0	36	8.4	25	49.0
3/29/05	0.022	8.8	13.0	51	7.3	31	34.0
4/8/05	0.030	12.0	11.0	51	7.3	38	32.0
4/11/05	0.021	5.3	9.4	44	7.2	29	31.0
5/18/05	0.014	1.2	7.6	41	7.6	28	31.0
Samples	20	20	20	20	20	20	20
Maximum	0.081	27.0	18.0	100	9.1	53	75.0
Minimum	0.011	1.2	7.6	36	5.7	25	30.0
Mean	0.039**	10.4	11.6	60	7.4	40	40.4

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Bioswale SR 405 MP 26

WSDOT was unable to directly collect inflow samples to this BMP. See Closed Vault SR 405 MP 26 for Untreated Runoff values.

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.056	4.5	7.4	23	4.8	10	35.0
12/20/03	0.045	0.8	6.2	16	5.9	15	42.0
1/15/04	0.005	3.2	6.7	26	5.1	16	39.0
1/26/04	0.043	2.3	6.0	16	5.8	13	35.0
1/30/04	0.053	3.0	4.5	14	4.3	12	20.0
2/9/04	0.057	15.0	8.3	24	6.3	12	29.0
2/16/04	0.051	1.9	6.0	17	5.2	11	30.0
2/17/04	0.027	6.8	6.3	20	4.9	9.3	29.0
2/27/04	0.045	3.3	9.0	24	5.5	15	41.0
3/4/04	0.051	2.4	7.9	25	6.2	16	38.0
Samples	10	10	10	10	10	10	10
Maximum	0.057	15.0	9.0	26	6.3	16	42.0
Minimum	0.027**	0.8	4.5	14	4.3	9	20.0
Mean	0.043	4.3	6.8	21	5.4	13	33.8

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Composite Sampling Data

Dry Pond I-5 MP 188

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA		Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.022	3.0	4.4	37	3.3	31	10.0		12/5/03	0.017	1.5	3.2	29	2.5	22	16.0
12/13/03	0.015	1.8	6.2	52	4.0	44	16.0		12/13/03	0.018	2.3	4.4	33	2.8	21	13.0
12/16/03	0.025	3.2	6.0	58	4.1	49	21.0		12/16/03	0.019	2.5	3.2	25	2.7	21	14.0
12/20/03	0.016	1.7	5.9	61	4.8	53	18.0		12/20/03	NS	NS	NS	NS	NS	NS	NS
1/8/04	0.199	33.0	19.0	200	7.5	95	35.0		1/8/04	0.045	5.5	6.4	41	2.9	21	14.0
1/15/04	0.019	4.8	6.7	49	6.9	39	15.0		1/15/04	0.020	2.0	2.0	38	2.5	32	18.0
1/26/04	0.014	0.75	4.0	33	3.6	28	10.0		1/26/04	0.034	6.0	3.4	29	2.8	24	18.0
1/30/04	NS	NS	NS	NS	NS	NS	NS		1/30/04	0.020	2.0	2.7	22	2.6	24	15.0
2/5/04	0.018	0.4	4.4	52	3.9	37	15.0		2/5/04	0.018	2.0	3.1	24	2.2	20	17.0
2/9/04	NS	NS	NS	NS	NS	NS	NS		2/9/04	0.018	2.4	2.7	30	2.3	20	18.0
2/17/04	NS	NS	NS	NS	NS	NS	NS		2/17/04	0.062	9.2	4.2	16	2.8	12	17.0
2/27/04	NS	NS	NS	NS	NS	NS	NS		2/27/04	0.033	8.0	4.2	13	2.5	2.5	15.0
3/4/04	0.033	1.0	6.8	53	4.6	33	13.0		3/4/04	0.046	8.0	4.5	27	3.1	16	13.0
3/10/04	0.034	2.0	7.6	31	5.7	20	10.0		3/10/04	0.035	4.4	4.2	20	3.2	12	12.0
5/24/04	0.067	5.2	20.0	58	18.0	54	21.0		5/24/04	NS	NS	NS	NS	NS	NS	NS
5/26/04	0.020	4.0	14.0	47	12.0	43	16.0		5/26/04	NS	NS	NS	NS	NS	NS	NS
Samples	12	12	12	12	12	12	12		Samples	13	13	13	13	13	13	13
Maximum	0.199	33.0	20.0	200	18.0	95	35.0		Maximum	0.062	9.2	6.4	41	3.2	32	18.0
Minimum	0.014	0.8**	4.0	31	3.3	20	10.0		Minimum	0.017	1.5	2.0	13	2.2	3	12.0
Mean	0.040	5.1	8.8	61	6.5	44	16.7		Mean	0.030	4.3	3.7	27	2.7	19	15.4

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Unimproved Ditch SR 525 MP 2

WSDOT was unable to directly collect inflow samples to this BMP. See Wet Pond SR 525 MP 3 for Untreated Runoff values.

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.023	1.4	11.0	35	11.0	20	41.0
11/2/04	0.034	3.0	9.0	29	6.3	21	40.0
11/24/04	0.120	5.4	8.8	47	6.0	29	38.0
12/9/04	0.005**	2.2	4.5	19	4.1	13	41.0
12/21/05	0.070	5.8	5.9	35	4.6	16	45.0
12/30/04	0.022	3.0	4.2	21	2.3	14	43.0
3/28/05	0.032	1.6	6.1	20	4.5	11	23.0
5/16/05	0.026	3.8	6.9	23	6.6	17	23.0
5/18/05	0.028	2.2	7.8	31	7.2	14	43.0
Samples	9	9	9	9	9	9	9
Maximum	0.120	5.8	11.0	47	11.0	29	45.0
Minimum	0.022	1.4	4.2	19	2.3	11	23.0
Mean	0.040**	3.2	7.1	29	5.8	17	37.4

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Unimproved Ditch SR 405 MP 28

WSDOT was unable to directly collect inflow samples to this BMP. See Open Vault SR 405 MP 30 for Untreated Runoff values.

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.048	0.25	6.7	62	5.8	55	27.0
12/13/03	0.044	0.5	6.1	68	5.7	59	29.0
12/16/03	0.053	2.3	6.7	64	5.6	70	27.0
12/20/03	0.031	0.25	7.4	75	6.2	72	30.0
11/2/04	0.057	5.6	6.7	53	6.7	48	13.0
11/30/04	0.005**	1.8	8.5	62	8.5	58	26.0
12/6/04	0.005**	2.6	8.2	66	6.6	65	28.0
12/9/04	0.044	2.0	5.2	60	6.0	50	26.0
12/10/04	0.051	1.0	7.7	52	4.6	46	24.0
12/30/04	0.076	1.4	3.8	51	3.3	40	23.0
3/28/05	0.056	1.8	9.5	50	9.8	49	26.0
4/8/05	0.028	0.4	7.3	51	6.6	39	28.0
Samples	12	12	12	12	12	12	12
Maximum	0.076	5.6	9.5	75	9.8	72	30.0
Minimum	0.028	0.5**	3.8	50	3.3	39	13.0
Mean	0.042**	1.7	7.0	60	6.3	54	25.6**

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

Composite Sampling Data

Ecology Embankment SR 167 MP 16

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/1/04	0.029	67.0	32.0	220	12.0	110	33.0
11/2/04	0.100	49.0	45.0	300	11.0	96	41.0
11/16/04	0.370	210.0	87.0	520	16.0	140	49.0
11/24/04	0.280	68.0	50.0	440	11.0	150	53.0
11/30/04	0.048	76.0	41.0	290	5.7	86	17.0
12/9/04	0.072	87.0	32.0	230	11.0	100	23.0
12/10/04	0.031	190.0	80.0	500	8.3	120	51.0
12/13/04	0.420	150.0	110.0	620	7.5	83	46.0
12/27/04	0.190	38.0	39.0	270	18.0	170	71.0
12/30/04	0.390	140.0	62.0	480	11.0	170	76.0
1/18/05	0.260	100.0	54.0	460	23.0	270	110.0
3/1/05	0.540	250.0	120.0	560	33.0	200	77.0
3/17/05	0.046	370.0	94.0	630	23.0	120	56.0
3/28/05	0.180	16.0	27.0	150	17.0	110	25.0
4/8/05	0.520	99.0	93.0	440	13.0	98	34.0
4/11/05	0.130	22.0	38.0	190	20.0	120	32.0
Samples	16	16	16	16	16	16	16
Maximum	0.540	370.0	120.0	630	33.0	270	110.0
Minimum	0.029	16.0	27.0	150	5.7	83	17.0
Mean	0.225	120.8	62.8	394	15.0	134	49.6**

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/1/04	NS	NS	NS	NS	NS	NS	NS
11/2/04	0.005**	10.0	9.6	98	6.0	63	14.0
11/16/04	0.005**	2.0	12.0	63	10.0	43	27.0
11/24/04	NS	NS	NS	NS	NS	NS	NS
11/30/04	NS	NS	NS	NS	NS	NS	NS
12/9/04	0.014	2.4	9.0	38	7.1	34	29.0
12/10/04	0.041	4.2	11.0	35	6.5	23	27.0
12/13/04	0.041	13.0	11.0	35	4.7	15	19.0
12/27/04	0.018	2.4	12.0	35	8.3	24	35.0
12/30/04	0.039	0.4	6.0	30	5.0	25	36.0
1/18/05	0.005**	0.4	5.2	30	3.2	22	63.0
3/1/05	0.028	10.0	8.5	26	7.9	20	56.0
3/17/05	0.040	22.0	26.0	69	22.0	46	39.0
3/28/05	0.027	2.8	15.0	31	14.0	30	31.0
4/8/05	0.014	2.4	9.8	54	7.7	23	33.0
4/11/05	0.005**	0.4	7.1	20	6.9	16	34.0
Samples	13	13	13	13	13	13	13
Maximum	0.041**	22.0	26.0	98	22.0	63	63.0
Minimum	0.014	2.0**	5.2	20	3.2	15	14.0
Mean	0.022**	5.6	10.9	43	8.4	30	34.1**

**Value reported incorrectly in the 2005 NPDES report. Value has been amended.

WSDOT was unable to directly collect inflow samples to this BMP. Representative untreated runoff was collected from the Curb & Gutter Control Site I-5 MP 184.

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/3/05	0.131	60.0	24.4	129	6.3	48	9.8
12/20/05	0.521	303.0	49.2	375	7.0	53	26.0
12/21/05	0.559	334.0	81.4	469	6.8	61	19.7
12/28/05	0.163	89.0	19.3	114	5.0	41	8.8
1/6/06	0.368	257.0	41.7	261	4.0	38	8.6
1/10/06	0.601	744.0	56.2	363	1.9	34	8.6
1/17/06	0.339	255.0	39.5	240	4.4	27	9.0
Samples	7	7	7	7	7	7	7
Maximum	0.601	744.0	81.4	469	7.0	61	26.0
Minimum	0.131	60.0	19.3	114	1.9	27	8.6
Mean	0.383	291.7	44.5	279	5.1	43	12.9

Vegetated Filter Strip I-5 MP 185

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/3/05	0.620	3.0	8.3	21	6.9	13	19.7
12/20/05	0.261	7.5	8.3	28	7.6	25	59.2
12/21/05	0.093	3.0	7.0	20	6.9	21	36.0
12/28/05	0.064	4.0	5.4	13	4.5	11	14.3
1/6/06	0.070	5.5	5.9	21	4.2	12	12.3
1/10/06	0.071	7.0	3.8	16	2.9	12	13.9
1/17/06	0.062	4.8	5.6	13	4.3	0.3	15.4
Samples	7	7	7	7	7	7	7
Maximum	0.620	7.5	8.3	28	7.6	25	59.2
Minimum	0.062	3.0	3.8	13	2.9	11	12.3
Mean	0.177	5.0	6.3	19	5.3	13	24.4

WSDOT was unable to directly collect inflow samples to this BMP. Representative untreated runoff was collected from the Curb & Gutter Control Site I-5 MP 184.

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/3/05	0.131	60.0	24.4	129	6.3	48	9.8
12/20/05	0.521	303.0	49.2	375	7.0	53	26.0
12/21/05	0.559	334.0	81.4	469	6.8	61	19.7
12/28/05	0.163	89.0	19.3	114	5.0	41	8.8
1/6/06	0.368	257.0	41.7	261	4.0	38	8.6
1/10/06	0.601	744.0	56.2	363	1.9	34	8.6
1/17/06	0.339	255.0	39.5	240	4.4	27	9.0
Samples	7	7	7	7	7	7	7
Maximum	0.601	744.0	81.4	469	7.0	61	26.0
Minimum	0.131	60.0	19.3	114	1.9	27	8.6
Mean	0.383	291.7	44.5	279	5.1	43	12.9

Compost Shoulder I-5 MP 186 "A"

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/3/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
12/20/05	NS	NS	NS	NS	NS	NS	NS
12/21/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
12/28/05	NF*	NF*	NF*	NF*	NF*	NF*	NF*
1/6/06	NF*	NF*	NF*	NF*	NF*	NF*	NF*
1/10/06	0.138	47.0	9.2	39	2.7	78	5.1
1/17/06	NF*	NF*	NF*	NF*	NF*	NF*	NF*
Samples	1	1	1	1	1	1	1
Maximum	0.138	47.0	9.2	39	2.7	78	5.1
Minimum	0.138	47.0	9.2	39	2.7	78	5.1
Mean	0.138	47.0	9.2	39	2.7	78	5.1

*All runoff infiltrated on these dates. However, it is not known how these events effected average pollutant concentrations leaving the BMP. Therefore, they were not factored into the overall BMP pollutant reduction comparisons (Max, Min, and Mean values).

Composite Sampling Data

WSDOT was unable to directly collect inflow samples to this BMP. Representative untreated runoff was collected from the Curb & Gutter Control Site I-5 MP 184.

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/3/05	0.131	60.0	24.4	129	6.3	48	9.8
12/20/05	0.521	303.0	49.2	375	7.0	53	26.0
12/21/05	0.559	334.0	81.4	469	6.8	61	19.7
12/28/05	0.163	89.0	19.3	114	5.0	41	8.8
1/6/06	0.368	257.0	41.7	261	4.0	38	8.6
1/10/06	0.601	744.0	56.2	363	1.9	34	8.6
1/17/06	0.339	255.0	39.5	240	4.4	27	9.0
Samples	7	7	7	7	7	7	7
Maximum	0.601	744.0	81.4	469	7.0	61	26.0
Minimum	0.131	60.0	19.3	114	1.9	27	8.6
Mean	0.383	291.7	44.5	279	5.1	43	12.9

Compost Shoulder I-5 MP 186 "B"

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/3/05	0.053	13.0	10.7	21	5.3	10	26.4
12/20/05	NS	NS	NS	NS	NS	NS	NS
12/21/05	0.063	11.0	8.5	20	7.6	19	41.4
12/28/05	0.041	15.0	5.6	21	4.3	9	22.7
1/6/06	0.058	17.0	8.5	28	3.9	15	12.9
1/10/06	0.096	41.0	8.9	39	1.8	15	11.9
1/17/06	0.049	13.0	7.7	74	4.8	5	27.8
Samples	6	6	6	6	6	6	6
Maximum	0.096	41.0	10.7	74	7.6	19	41.4
Minimum	0.041	11.0	5.6	20	1.8	5	11.9
Mean	0.060	18.3	8.3	34	4.6	12	23.8

Compost Shoulder I-5 MP 109

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/1/03	NS	NS	NS	NS	NS	NS	NS
2/14/03	NS	NS	NS	NS	NS	NS	NS
2/18/03*	NS	NS	NS	NS	NS	NS	NS
3/21/03	NS	NS	NS	NS	NS	NS	NS
3/25/03	NS	NS	NS	NS	NS	NS	NS
4/4/03	NS	NS	NS	NS	NS	NS	NS
4/7/03	NS	NS	NS	NS	NS	NS	NS
11/16/03	NS	NS	NS	NS	NS	NS	NS
11/17/03	NS	NS	NS	NS	NS	NS	NS
11/23/03	0.110	58.0	29.0	140	5.6	53	16.0
11/28/03	NS	NS	NS	NS	NS	NS	NS
12/5/03	0.214	90.0	38.0	200	6.7	94	27.0
12/13/03	0.179	120.0	28.0	150	4.1	60	12.0
1/1/04	NS	NS	NS	NS	NS	NS	NS
1/23/04	0.411	342.0	62.0	310	5.7	63	34.0
1/28/04	0.227	170.0	38.0	190	3.8	51	24.0
2/13/04	0.219	100.0	40.0	200	10.0	88	37.0
3/5/04	0.299	190.0	45.0	240	5.4	70	28.0
3/19/04	0.084	280.0	59.0	290	12.0	90	33.0
3/24/04	0.360	190.0	36.0	190	7.2	69	20.0
Samples	9	9	9	9	9	9	9
Maximum	0.411	342.0	62.0	310	12.0	94	37.0
Minimum	0.084	58.0	28.0	140	3.8	51	12.0
Mean	0.234	171.1	41.7	212	6.7	71	25.7

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/1/03	NS	9.0	NS	NS	NS	NS	NS
2/14/03	0.300	12.0	8.2	32	5.8	24	19.0
2/18/03*	NS	12.0	6.8	24	0.5**	16	19.0
3/21/03	0.200	14.0	8.5	29	6.0	19	26.0
3/25/03	0.210	10.0	7.2	27	5.4	25	21.0
4/4/03	0.260	100.0	17.0	52	5.8	20	19.0
4/7/03	0.280	11.0	8.1	25	5.8	17	21.0
11/16/03	0.400	9.0	7.9	33	***	***	18.0
11/17/03	0.340	6.0	7.3	30	6.6	23	23.0
11/23/03	NS	NS	NS	NS	NS	NS	NS
11/28/03	0.200	2.8	7.6	33	5.4	18	16.0
12/5/03	0.307	6.5	6.9	36	4.5	15	19.0
12/13/03	0.262	5.2	5.7	69	4.9	22	17.0
1/1/04	0.280	12.0	8.3	30	4.8	18	19.0
1/23/04	NS	NS	NS	NS	NS	NS	NS
1/28/04	NS	NS	NS	NS	NS	NS	NS
2/13/04	0.243	6.8	6.3	29	4.8	20	18.0
3/5/04	0.286	34.0	14.0	58	7.5	29	23.0
3/19/04	NS	NS	NS	NS	NS	NS	NS
3/24/04	NS	NS	NS	NS	NS	NS	NS
Samples	13	15	14	14	13	13	14
Maximum	0.400	100.0	17.0	69	7.5	29	26.0
Minimum	0.200	2.8	5.7	24	0.5	15	16.0
Mean	0.274	16.7	8.6	36	5.2	20	19.9

*Sample date reported incorrectly in 2004 NPDES report. Date has been amended.
**Value reported incorrectly in the 2005 NPDES report. Value has been amended.
***Samples were not preserved properly.

Appendix 6-C Stormwater Treatment Facility Effectiveness, Grab Sampling Data

Appendix 6-C

Grab Sampling Data

E. coli & fecal coliform concentrations are the # of colony forming units/100mL.
Total Cu, Total Zn, Dis. Cu, and Dis. Zn concentrations are in ug/L.
TP stands for Total Phosphorus, concentrations in mg/L.
TPH stands for Total Petroleum Hydrocarbon, concentrations in mg/L.
TSS stands for Total Suspended Solids, concentrations in mg/L.
HA stands for hardness, concentrations in mg $CaCO_3$/L.
NS means no sample was collected.
Values in grey represent No Detection and are reported as half the detection limit.

Sites Monitored For All Parameters Except TPH:

Wet Pond SR 525 MP 3.3

Untreated Runoff

Sample Date	E. Coli	Fecal Coliform	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/17/2005	170	170	0.140	120.0	28.0	140	5.8	32	26.0
1/17/2005	170	140	NS	NS	NS	NS	NS	NS	NS
2/4/2005	130	240	0.200	48.0	22.0	86	6.6	17	24.0
2/4/2005	70	500	NS	NS	NS	NS	NS	NS	NS
3/16/2005	80	80	0.027	100.0	41.0	140	12.0	29	27.0
3/16/2005	NS	NS	NS	NS	NS	NS	NS	NS	NS
3/29/2005	80	80	0.034	6.8	13.0	43	7.1	19	31.0
4/7/2005	39	220	0.063	56.0	24.0	94	5.5	17	23.0
4/7/2005	300	300	NS	NS	NS	NS	NS	NS	NS
4/7/2005	NS	NS	NS	NS	NS	NS	NS	NS	NS
Samples	8	8	5	5	5	5	5	5	5
Maximum	300	500	0.200	120.0	41.0	140	12.0	32	31.0
Minimum	39	80	0.027	6.8	13.0	43	5.5	17	23.0
Arithmetic Mean	130	216	0.093	66.2	25.6	101	7.4	23	26.2
Geometric Mean	109	182	0.069	46.6	23.9	93	7.1	22	26.1

Treated Runoff

Sample Date	E. Coli	Fecal Coliform	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/17/2005	1	1	0.014	4.0	0.5	6	0.5	2.5	57.0
1/17/2005	1	1	NS	NS	NS	NS	NS	NS	NS
2/4/2005	1	1	0.012	4.0	1.4	20	1.5	7	78.0
2/4/2005	4	4	NS	NS	NS	NS	NS	NS	NS
3/16/2005	2	2	0.014	3.6	0.5	30	0.5	31	120.0
3/16/2005	1	1	NS	NS	NS	NS	NS	NS	NS
3/29/2005	1	1	0.005	2.0	3.6	8	3.0	7	50.0
4/7/2005	11	11	0.005	1.0	1.6	12	1.8	5	50.0
4/7/2005	8	8	NS	NS	NS	NS	NS	NS	NS
4/7/2005	7	7	NS	NS	NS	NS	NS	NS	NS
Samples	10	10	5	5	5	5	5	5	5
Maximum	11	11	0.014	4.0	3.6	30	3.0	31	120.0
Minimum	2	2	0.012	1.0	1.4	6	1.5	5	50.0
Arithmetic Mean	4	4	0.010	2.9	1.5	15	1.5	11	71.0
Geometric Mean	2	2	0.009	2.6	1.2	13	1.2	7	66.8

Open Vault SR 405 MP 29.5

Untreated Runoff

Sample Date	E. Coli	Fecal Coliform	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/17/2005	1600	1600	0.790	340.0	85.0	410	8.6	38	42.0
1/17/2005	11	11	NS	NS	NS	NS	NS	NS	NS
2/4/2005	240	240	0.130	46.0	35.0	110	12.0	38	25.0
2/4/2005	1600	1600	NS	NS	NS	NS	NS	NS	NS
3/16/2005	170	170	0.170	170.0	73.0	270	19.0	67	31.0
3/20/2005	500	500	0.110	44.0	30.0	120	14.0	55	48.0
3/28/2005	500	900	0.210	37.0	39.0	160	18.0	98	68.0
3/29/2005	240	300	0.026	4.8	11.0	56	6.4	39	32.0
4/7/2005	350	350	0.130	88.0	50.0	220	12.0	35	34.0
4/7/2005	300	300	NS	NS	NS	NS	NS	NS	NS
Samples	10	10	7	7	7	7	7	7	7
Maximum	1600	1600	0.790	340.0	85.0	410	19.0	98	68.0
Minimum	11	11	0.026	4.8	11.0	56	6.4	35	25.0
Arithmetic Mean	551	597	0.224	104.3	46.1	192	12.9	53	40.0
Geometric Mean	306	332	0.145	56.5	39.1	162	12.1	49	38.1

Treated Runoff

Sample Date	E. Coli	Fecal Coliform	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/17/2005	220	220	0.120	60.0	26.0	150	11.0	67	110.0
1/17/2005	300	300	NS	NS	NS	NS	NS	NS	NS
2/4/2005	30	30	0.060	36.0	16.0	98	7.6	52	80.0
2/4/2005	80	130	NS	NS	NS	NS	NS	NS	NS
3/16/2005	13	23	0.110	32.0	14.0	58	7.2	21	71.0
3/20/2005	NS	NS	NS	NS	NS	NS	NS	NS	NS
3/28/2005	7	11	0.022	7.8	13.0	47	7.3	40	32.0
3/29/2005	50	50	0.045	9.0	12.0	52	8.4	29	33.0
4/7/2005	13	13	0.034	9.0	10.0	46	7.0	19	32.0
4/7/2005	23	23	NS	NS	NS	NS	NS	NS	NS
Samples	9	9	6	6	6	6	6	6	6
Maximum	300	300	0.120	60.0	26.0	150	11.0	67	110.0
Minimum	7	11	0.022	7.8	10.0	46	7.0	19	32.0
Arithmetic Mean	82	89	0.065	25.6	15.2	75	8.1	38	59.7
Geometric Mean	39	46	0.055	18.8	14.4	68	8.0	34	52.6

Unimproved Ditch SR 525 MP 2.1

WSDOT was unable to directly collect inflow samples to this BMP. See Wet Pond SR 525 MP 3.3 for Untreated Runoff values.

Sample Date	E. Coli	Fecal Coliform	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/17/2005	17	17	0.029	5.8	5.4	23	2.9	10	45.0
1/17/2005	4	4	NS	NS	NS	NS	NS	NS	NS
2/4/2005	500	500	0.120	11.0	8.4	24	7.3	12	31.0
2/4/2005	13	13	NS	NS	NS	NS	NS	NS	NS
3/16/2005	240	240	0.160	5.2	10.0	18	8.1	11	70.0
3/20/2005	4	4	0.060	3.6	8.0	18	6.9	10	44.0
4/7/2005	23	23	0.014	2.4	7.7	16	6.5	11	39.0
4/7/2005	240	240	NS	NS	NS	NS	NS	NS	NS
Samples	8	8	5	5	5	5	5	5	5
Maximum	500	500	0.160	11.0	10.0	24	8.1	12	70.0
Minimum	4	4	0.014	2.4	5.4	16	2.9	10	31.0
Arithmetic Mean	130	130	0.077	5.6	7.9	20	6.3	11	45.8
Geometric Mean	35	35	0.054	4.9	7.7	20	6.0	11	44.1

Grab Sampling Data

Unimproved Ditch SR 405 MP 27.7

WSDOT was unable to directly collect inflow samples to this BMP.
See Open Vault SR 405 MP 29.5 for Untreated Runoff values.

Sample Date	E. Coli	Fecal Coliform	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/17/2005	1	1	0.014	0.4	3.7	71	2.6	55	57.0
1/17/2005	4	4	NS	NS	NS	NS	NS	NS	NS
2/4/2005	70	70	NS	NS	NS	NS	NS	NS	NS
4/7/2005	140	140	0.033	3.6	7.8	61	6.5	34	27.0
Samples	4	4	2	2	2	2	2	2	2
Maximum	140	140	0.033	3.6	7.8	71	6.5	55	57.0
Minimum	4	4	0.014	3.6	3.7	61	2.6	34	27.0
Arithmetic Mean	54	54	0.024	2.0	5.8	66	4.6	45	42.0
Geometric Mean	14.1	14	0.021	1.2	5.4	66	4.1	43	39.2

Grab Sampling Data

Sites Monitored For Fecal Coliform & TPH:

Untreated Runoff | **Treated Runoff**

Wet Pond SR 522 MP 16.5

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
12/28/2005	180	0.025	0.67		12/28/2005	10	0.025	0.05
1/5/2006	10	0.025	1.39		1/5/2006	20	0.025	0.05
2/23/2006	1000	0.10	3.95		2/23/2006	30	0.03	0.13
3/8/2006	1200	0.025	1.94		3/8/2006	220	0.17	0.75
5/23/2006	4000	NS	NS		5/23/2006	160	0.03	0.19
Samples	5	4	4		Samples	5	5	5
Maximum	4000	0.10	3.95		Maximum	220	0.17	0.75
Minimum	10	0.10	0.67		Minimum	10	0.17	0.13
Arithmetic Mean	1278	0.04	1.99		Arithmetic Mean	88	0.06	0.23
Geometric Mean	387	0.04	1.63		Geometric Mean	46	0.04	0.14

Wet Pond SR 525 MP 2.4

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
12/28/2005	310	0.025	2.17		12/28/2005	250	0.025	0.11
1/5/2006	1300	0.025	2.21		1/5/2006	130	0.03	0.06
2/23/2006	470	0.025	0.98		2/23/2006	260	0.03	0.54
3/8/2006	920	0.025	2.14		3/8/2006	310	0.025	0.20
5/22/2006	4000	0.025	2.26		5/22/2006	102	0.025	0.05
5/23/2006	4000	0.08	2.17		5/23/2006	10	0.025	0.05
Samples	6	6	6		Samples	6	6	6
Maximum	4000	0.08	2.26		Maximum	310	All samples are Below Detection	0.54
Minimum	310	0.08	0.98		Minimum	10	All samples are Below Detection	0.11
Arithmetic Mean	1833	0.03	1.99		Arithmetic Mean	177	0.03	0.17
Geometric Mean	1186	0.03	1.92		Geometric Mean	118	0.03	0.11

Wet Pond SR 18 MP 8.04

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
3/8/2006	1700	0.025	1.83		3/8/2006	5400	0.025	0.05
4/21/2006	860	0.025	0.27		4/21/2006	6	0.025	0.055
Samples	2	2	2		Samples	2	2	2
Maximum	1700	All samples are Below Detection	1.83		Maximum	5400	All samples are Below Detection	All samples are Below Detection
Minimum	860	All samples are Below Detection	0.27		Minimum	6	All samples are Below Detection	All samples are Below Detection
Arithmetic Mean	1280	0.025	1.05		Arithmetic Mean	2703	0.025	0.05
Geometric Mean	1209	0.025	0.70		Geometric Mean	180	0.025	0.05

Bioswale SR 18 MP 13.11

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
3/8/2006	110	0.025	1.25		3/8/2006	80	0.025	0.52
4/3/2006	110	0.03	0.58		4/3/2006	50	0.025	0.29
Samples	2	2	2		Samples	2	2	2
Maximum	110	All samples are Below Detection	1.25		Maximum	80	All samples are Below Detection	0.52
Minimum	110	All samples are Below Detection	0.58		Minimum	50	All samples are Below Detection	0.29
Arithmetic Mean	110	0.03	0.92		Arithmetic Mean	65	0.025	0.41
Geometric Mean	110	0.03	0.85		Geometric Mean	63	0.025	0.39

Grab Sampling Data

Bioswale SR 14 MP 9.8

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
12/21/2005	240	1.30	5.07		12/21/2005	500	NS	NS
12/30/2005	7	NS	NS		12/30/2005	2	NS	NS
1/17/2006	30	NS	NS		1/17/2006	4	NS	NS
3/8/2006	900	1.42	5.00		3/8/2006	8	0.30	0.09
3/9/2006	50	NS	NS		3/9/2006	17	NS	NS
Samples	5	2	2		Samples	5	1	1
Maximum	900	1.42	5.07		Maximum	500	0.30	All samples are Below Detection
Minimum	7	1.30	5.00		Minimum	2	0.30	All samples are Below Detection
Arithmetic Mean	245	1.36	5.04		Arithmetic Mean	106	0.30	0.09
Geometric Mean	74	1.36	5.03		Geometric Mean	14	0.30	0.09

Wet Pond SR 500 MP 5.42

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
1/17/2006	300	NS	NS		1/17/2006	14	NS	NS
2/2/2006	300	1.77	2.48		2/2/2006	1	0.04	0.09
3/8/2006	500	3.73	13.40		3/8/2006	50	0.04	0.09
Samples	3	2	2		Samples	3	2	2
Maximum	500	3.73	13.40		Maximum	50	All samples are Below Detection	All samples are Below Detection
Minimum	300	1.77	2.48		Minimum	14	All samples are Below Detection	All samples are Below Detection
Arithmetic Mean	367	2.75	7.94		Arithmetic Mean	22	0.04	0.09
Geometric Mean	356	2.57	5.76		Geometric Mean	9	0.04	0.09

Wet Pond SR 525 MP 1.8

Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil		Sample Date	Fecal Coliform	TPH Diesel	TPH Motor Oil
12/28/2005	170	0.025	0.95		12/28/2005	100	0.025	0.05
1/5/2006	470	0.025	2.26		1/5/2006	10	0.025	0.05
2/23/2006	60	0.025	1.60		2/23/2006	170	0.03	0.06
3/8/2006	5	0.025	3.95		3/8/2006	130	0.025	0.05
5/23/2006	4000	0.025	1.05		5/23/2006	1	0.025	0.05
Samples	5	5	5		Samples	5	5	5
Maximum	4000	All samples are Below Detection	3.95		Maximum	170	All samples are Below Detection	All samples are Below Detection
Minimum	60	All samples are Below Detection	0.95		Minimum	10	All samples are Below Detection	All samples are Below Detection
Arithmetic Mean	941	0.025	1.96		Arithmetic Mean	82	0.03	0.05
Geometric Mean	157	0.025	1.70		Geometric Mean	29	0.03	0.05

Sites Monitored Only For TPH:

Untreated Runoff

WSDOT was unable to directly collect inflow samples to this BMP.
Representative untreated runoff was collected from the Curb & Gutter Control Site I-5 MP 184.3

Sample Date	TPH Diesel	TPH Motor Oil
11/3/2005	0.025	0.56
12/20/2005	0.025	3.85
12/21/2005	0.025	5.08
1/10/2006	0.025	1.01
1/17/2006	0.025	2.36
Samples	5	5
Maximum	All samples are Below Detection	5.08
Minimum	All samples are Below Detection	0.56
Mean	0.025	2.57

Treated Runoff

Vegetated Filter Strip I-5 MP 185.4

Sample Date	TPH Diesel	TPH Motor Oil
11/3/2005	0.025	0.05
12/20/2005	0.03	0.31
12/21/2005	0.025	2.48
1/10/2006	0.025	0.05
1/17/2006	0.025	0.05
Samples	5	5
Maximum	All samples are Below Detection	2.48
Minimum	All samples are Below Detection	0.31
Mean	0.03	0.59

WSDOT was unable to directly collect inflow samples to this BMP.
Representative untreated runoff was collected from the Curb & Gutter Control Site I-5 MP 184.3

Sample Date	TPH Diesel	TPH Motor Oil
11/3/2005	0.025	0.56
12/20/2005	0.025	3.85
12/21/2005	0.025	5.08
1/10/2006	0.025	1.01
1/17/2006	0.025	2.36
Samples	5	5
Maximum	All samples are Below Detection	5.08
Minimum	All samples are Below Detection	0.56
Mean	0.025	2.57

Compost Shoulder I-5 MP 185.6 "B"

Sample Date	TPH Diesel	TPH Motor Oil
11/3/2005	0.025	2.2
12/20/2005	NS	NS
12/21/2005	0.025	0.19
1/10/2006	0.025	0.46
1/17/2006	0.025	0.39
Samples	4	4
Maximum	All samples are Below Detection	2.2
Minimum	All samples are Below Detection	0.19
Mean	0.025	0.81

Appendix 7-A Stormwater Treatment Facility Construction

OLYMPIC REGION PROJECTS SUBSTANTIALLY COMPLETED BETWEEN JULY 1, 2005 AND JUNE 30, 2006

State Route	Milepost	Offset direction and distance	County	Project Name	BMP Type	Facility Size	Stand alone retrofit yes/no
104	8.86 - 9.12	Left 30 ft.	Jefferson	SR104 Jct. SR 19 Intersection	Bioswale	0.10 acres	No
161	19.55 - 21.66	Left 120 ft.	Pierce	SR161 204th E. to 176th St.E	Detention Pond A2 w/ Vortechnics Unit	0.26 acres	No
		Left 60 ft.			Bioswale	0.02 acres	
		Right 60 ft.			Bioswale	0.03 acres	
		Left 60 ft.			Bioinfiltration Swale	0.12 acres	
		Right 60 ft.			Bioinfiltration Swale	0.14 acres	
		Right 75 ft.			Infiltration Pond B1	0.5 acres	
		Left 90 ft.			Infiltration Pond C1	0.75 acres	
161	17.44 - 19.55	Left 60 ft.	Pierce	SR161 234th St. E. to 204th St. E.	Det. Pond A1	0.83 ac-ft	No
		Left 30 ft.			Det. Pond D1	6.64 ac-ft	
		Right 25 ft.			Det. Pond D2	3.12 ac-ft	
		Left 60 ft.			Det. Pond D3	0.70 ac-ft	
		Left 60 ft.			Det. Pond E1	0.15 acres	
		Left 75 ft.			Infiltration Pond F1	0.03 acres	
		Left 60 ft.			Infiltration Pond F2	0.01 acres	
		Left 60 ft.			Veg. Filter Strip / Infiltration Ditch G1	0.03 acres	
		Right 60 ft.			Veg. Filter Strip / Infiltration Ditch G2	0.05 acres	
305	1.64	Left 30 ft.	Kitsap	SR 305 Madison Intersection Signal	Bioswale	0.10 acres	No
512	2.01 - 2.52	Left 40 ft.	Pierce	SR 512/SR7 Intersection Safety Improvement	Bioinfiltration swale	0.01 acres	No
		Left 30 ft.			Vortex-enhanced sediment system	n/a	